Issued October 1971

SOIL SURVEY

EASTERN FRESNO AREA

California

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
CALIFORNIA AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this soil survey was completed in 1962. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in this publication refer to conditions in the Area at the time the survey was in progress. This survey was made cooperatively by the Soil Conservation Service, University of California Agricultural Experiment Station, and Fresno County. It is part of the technical assistance furnished to the James, Sierra, Navelencia, Excelsior, Tranquillity, and Kings River Soil Conservation Districts.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for agriculture, industry, and recreation.

Locating Soils

All the soils of the Eastern Fresno Area are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the survey. This guide lists all of the soils of the Area in alphabetic order by map symbol. It shows the page where each kind of soil is described, and also the page for the capability unit, range site, or any other group in which the soil has been placed.

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils in the soil descriptions and in the section that discusses management of the soils for crops, for range and pasture, and for wildlife.

Game managers, sportsmen, and others concerned with wildlife will find information about soils and wildlife in the section "Wildlife."

Ranchers and others interested in range can find, under "Use of the Soils for Range," information about the suitability of the soils for range and also the plants that grow on each range site.

Engineers and builders will find, under "Engineering Uses of Soils," tables that give engineering descriptions of the soils in the Area and that name soil features that affect engineering practices and structures.

Scientists and others can read about how the soils were formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in the Eastern Fresno Area will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the Area," which gives additional information about the Area.

Cover picture: Irrigated vineyards, citrus groves, and deciduous fruit orchards on low alluvial terraces of the Kings River and rangeland on foothills of the Sierra Nevada. Courtesy Bank of America.

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UNITED STATES DEPARTMENT OF AGRICULTURE, UNIVERSITY OF CALIFORNIA AGRICULTURAL EXPERIMENT STATION

THE EASTERN FRESNO AREA comprises the central third of Fresno County (fig. 1). The Area is close to the geographic center of California and occupies part of the San Joaquin Valley and the western slope of the Sierra Nevada. It is bounded on the west by the Fresno Slough; on the east by the western boundaries of the Sierra and Sequoia National Forests; on the north by the San Joaquin River, which is the Madera County line; and on the south by Kings and Tulare Counties.

Figure 1.—Location of Eastern Fresno Area in California.

The total extent of the Area is about 1,109,156 acres. It is roughly 34 miles wide and 53 miles long, and is generally oriented in a northeast-southwest direction. Elevation ranges from about 160 to 4,000 feet. On the average, annual precipitation ranges from about 8 to 35 inches, and annual temperature ranges from about 53° to 63° F. Because of the variation in climate, the diversity of parent rock in the foothills, and the distribution pattern of alluvium in the San Joaquin Valley, the soils vary greatly.

Good to excellent soils, an abundant supply of water of good quality, and the favorable climate make the Eastern Fresno Area well suited to many kinds of farming. Because of these factors, Fresno County is now among the leading counties in the nation in the production of field, seed, fruit, and nut crops, as well as in the value of its nursery, livestock, poultry, and apiary products. As a result many industries related to farming have been attracted to the Area.

After crops were produced for a time, accumulations of salts and alkali reduced the productivity of the soils in many places. The soils in about 620 square miles of the county therefore were studied and mapped in 1900 (*23*)[1] to help the farmer reduce accumulations of salts and alkali on productive farmland and to locate soil areas not affected by salts and alkali. Three additional soil surveys of areas around Fresno were subsequently published in 1902 (*24*), 1914 (*25*), and 1919 (*26*). The present survey has been prepared to provide the more detailed information required by a rapidly developing and expanding agricultural and land use technology.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the Eastern Fresno Area, where they are located, and how they can be used. The soil

[1] Italic numbers in parentheses refer to Literature Cited, p. 320.

scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. As they traveled over the county, they observed the steepness, length, and shape of slopes; the size and speed of streams; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Fresno and Merced, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Vista coarse sandy loam, 3 to 9 percent slopes, is one of several phases within the Vista series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

The areas shown on the soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. The mapping units of this kind shown on the soil map of the Eastern Fresno Area are soil complexes.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Trimmer-Tretten complex, 15 to 45 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Granitic rock land is a land type in the Eastern Fresno Area.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the Eastern Fresno Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in an area, who want to compare different parts of an area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The Eastern Fresno Area consists of three main physiographic sections. These are Soils of the Valley Basin, Soils of the Eastside Valley Alluvial Plains, and Soils of the Uplands of the Sierra Nevada Foothills. The term valley in the sections refers to the San Joaquin Valley. The Valley Basin is subdivided into (1) basin flood plain and (2) basin rim. The Eastside Valley Alluvial Plains are subdivided into (1) recent alluvial fans and flood plains, (2) young alluvial fans, (3) low alluvial terraces, and (4) high alluvial terraces. The uplands of the Sierra Nevada foothills is not subdivided physiographically, but is divided on the basis of climate into the lower Sierra Nevada foothills and the upper Sierra Nevada foothills. The three sections roughly coincide with one or a combination of two or more soil associations. Each soil association, however, is in only one physiographic section. The soil associations in the Eastern Fresno Area are discussed in the following pages.

Soils of the Valley Basin

This physiographic section includes lands that form an axial trough of the San Joaquin Valley. It consists of (1) poorly drained soils of the basin flood plain and (2) somewhat excessively drained to poorly drained soils of the basin rim.

Poorly drained soils of the basin flood plain

Under natural conditions this part of the valley trough was seasonably flooded and marshy, and much fine-textured material was deposited. Soils of the flood plain formed mainly from areas of granitic rock in the Sierra Nevada, and were deposited at flood stage by the waters of the Kings River and by small streams draining the gently sloping fans to the east. The flood plain makes up about 46,000 acres, or nearly 4 percent of the survey area. Elevations range from 160 to 210 feet.

This flood plain is traversed by the meandering channel of the Fresno Slough, an intermittent distributary of the Kings River that joins the San Joaquin River near Mendota. Many other meandering drainageways cut across the flood plain. Present day stream control, flood protection, and deep well pumping have lowered the water table to about 60 feet. As a result, drainage has been improved, but surface runoff remains slow to very slow. One soil association is in this subdivision.

1. Merced-Temple association: Deep and very deep clay loams and clays

The Merced and Temple soils contain much organic matter and are dark colored. The organic matter is from decayed marsh vegetation, mainly tules, that grew on the soils prior to drainage and improvement.

The Merced soils make up about 52 percent of this association; the Temple soils, 41 percent; water areas, 4 percent; and minor soils, 3 percent.

The Merced soils have a thick, clay or clay loam surface layer. Deep cracks develop in these soils when they are dry and extend into the dense, olive-colored clay subsoil that is mottled in many places and contains many nodules of lime and gypsum. The Temple soils have a thinner surface layer than the Merced soils. The surface layer is loam or clay loam, and the subsoil is olive brown or olive and slightly finer textured than the surface layer. The subsoil has blocky or weak prismatic structure when dry. Lime in disseminated or nodular form is common in the subsoil. Medium-textured to coarse-textured material underlies the subsoil below a depth of about 40 inches. Excess neutral salts are present in places. A small percentage of this acreage is affected by salts and alkali.

Minor soils of this association are the Piper and Rossi. They occupy remnants of old stream levees or parts of the basin rim. The Mendota Wildlife Management Area near Whites Bridge also makes up a small percentage of the acreage of this association.

Most of the soils in this association have been leveled and are now intensively cultivated. Leveling has filled in most drainageways and has mixed the Piper and Rossi soils with the Merced and Temple soils. Levees along the Fresno Slough and a diversion of the slough southeast of Helm into a floodway protect the soils from flooding.

Irrigation water is supplied by private and irrigation district pumps that tap the ground water at a moderate depth. Careful management of tillage and irrigation water is needed. Soils of this association are used for cotton, rice, irrigated barley, field corn, and seed crops.

Somewhat excessively drained to poorly drained soils of the basin rim

The soils of the basin rim are next to and east of the basin flood plain. They occupy a broad, irregular area bordering the lower part of extensive young alluvial fans along the San Joaquin and Kings Rivers. The alluvium deposited by the two rivers is predominantly of granitic origin. The basin rim covers about 134,000 acres, or about 12 percent of the survey area. Elevations range from about 175 to 275 feet. Runoff is slow, and in places water becomes ponded in small depressions or playas. In the past most areas were above seasonal inundations of the basin flood plain, though the water table often rose to less than 6 feet from the surface and remained at this level for long periods. This permitted capillary rise and evaporation of moisture within the soil and the accumulation of soluble materials. As a result, most of the soils are saline-alkali affected. The natural cover consists of annual grasses and forbs and of plants that tolerate salts and alkali, such as saltgrass, spikeweed, and pickleweed. Three soil associations are in this subdivision.

2. Rossi-Waukena association: Deep, somewhat poorly drained and poorly drained, dominantly fine sandy loams that are saline-alkali

The soils of this association are closely intermingled and occupy a narrow area along the western part of the basin rim.

The Rossi soils make up about 70 percent of this association; the Waukena soils, about 25 percent; and minor soils, the remaining 5 percent.

Rossi soils are above the flood plain. In the past they were subject to frequent shallow flooding. Their surface layer is thin, gray to dark gray fine sandy loam to clay loam and moderately alkaline to strongly alkaline. The subsoil is dense, slowly permeable, olive clay loam. It generally contains nodular lime and iron oxides. The subsoil is typically saline-alkali affected and contains a large amount of adsorbed sodium. Thick layers of paler colored, permeable, medium-textured to coarse-textured, saline-alkali affected alluvium underlie the subsoil.

The Waukena soils have a surface layer of very thin, grayish-brown to light-gray, calcareous fine sandy loam or loam. The subsoil is a dense, columnar, strongly calcareous and strongly alkaline sandy clay loam. It is olive or pale olive and has dark staining on the peds.

Minor soils of this association are the Traver, Pond, Calhi, Cajon, and Piper. They are scattered at random throughout the association.

Only parts of the soils in this association have been leveled and reclaimed. Depth to the water table ranges from about 40 to 60 feet, and it is unlikely that further salinization or alkalization of the soils will occur. The soils are difficult to leach and reclaim. Reclaimed areas are fairly well suited to cotton, rice, sugar beets, and irrigated barley. Fairly good irrigated pasture also can be developed. Unreclaimed areas are used for alkali pasture. Near Whites Bridge and Tranquillity some areas have been diked and flooded by private gun clubs to attract game waterfowl. Some areas of this association are in the protective floodway for the Fresno Slough and cannot be cultivated.

3. Fresno-El Peco association: Somewhat poorly drained fine sandy loams that are saline-alkali and that are shallow or moderately deep to a hardpan

The principal soils of this association have a hardpan that is cemented with lime and silica and is fractured in places. The hardpan consists of cemented layers separated by uncemented permeable alluvium that severely restricts penetration of roots and water.

Fresno soils make up about 70 percent of this association; El Peco soils, about 20 percent; and minor soils, the remaining 10 percent.

Fresno soils have a light gray, sandy loam to clay loam, strongly alkaline and calcareous surface layer. The subsoil is dense, strongly alkaline and calcareous clay loam. It has blocky or prismatic structure when dry. The hardpan ranges from 2 to 18 inches in thickness. The soil material below the hardpan is medium textured to moderately coarse textured, and permeable. El Peco soils are similar to the Fresno soils, but lack a moderately developed subsoil. The Fresno and El Peco soils occupy both large and small areas throughout the association and occur in no particular pattern in relation to each other. The largest area of El Peco soils is near Raisin City.

Minor soils in this association are in the Calhi, Cajon, Hesperia, Pond, and Traver series. The Calhi soils, briefly described in the Traver-Calhi association, occur in widely scattered areas. The Cajon, Hesperia, and Traver soils occupy winding, partially aggraded channelways and low, meandering stream ridges. Small areas of Traver and Pond soils occur at random.

The soils in this association are very gently sloping, but because of microrelief of the Fresno, El Peco, Pond, and Traver soils the surface is rough and uneven and contains many small depressions that lack external drainage. Runoff therefore is very slow or may form playas in the gentle depressions. On the smooth sloping Calhi soils runoff is very slow because permeability of their surface layer is rapid.

Many of these soils have been leveled and reclaimed. Lowering the regional water table by pumping is the key to successful reclamation. Other methods needed to complete reclamation are shattering the hardpan, applying large amounts of gypsum, and thoroughly leaching the soil with good quality water.

Soils that are reclaimed are fairly well suited to alfalfa, cotton, field corn, irrigated barley, irrigated pasture, and sugar beets. Unreclaimed soils are used for alkali pasture or are left idle.

4. Traver-Calhi association: Somewhat poorly drained to somewhat excessively drained fine sandy loams and loamy sands that are saline-alkali and that are moderately deep or deep to compact silt

In extent this association is similar to the Fresno-El Peco association. It includes most of the basin rim land southeast of McMullin Grade, and part of the area near the San Joaquin River.

Traver soils make up 50 percent of this association; Calhi soils, 30 percent; and minor soils, 20 percent.

The Traver soils occupy fairly large areas on alluvium and are affected by salts and alkali. The largest areas are near the San Joaquin River on more recent alluvium or are near intermittent streams entering the basin rim. The Traver soils have a light-gray or light brownish-gray fine sandy loam or sandy loam surface layer that is calcareous and in many places is strongly alkaline. The subsoil is light brownish-gray, compact, massive or blocky sandy loam to clay loam that is calcareous and strongly alkaline. In places the subsoil overlies a moderately compact, silty substratum. A coarser textured more permeable alluvium is present in areas where the substratum is absent.

The Calhi soils are in the southeastern half of the basin rim. These soils formed on low-lying, stabilized dunes derived from sandy material deposited by prevailing northwesterly winds. They consist of light brownish-gray to light-gray, calcareous, loose loamy sand that overlies light-gray to pale-yellow, moderately alkaline to strongly alkaline, calcareous loamy sand to sand. The Calhi soils are commonly deep, but in places they overlie other soils or compact layers at a depth of about 2½ to 4 feet. The Calhi soils are generally not saline, but in places, are affected by an excess of adsorbed sodium in the subsurface.

Minor soils of this association are Fresno, El Peco, Cajon, Hesperia, Pond, and Wunjey. Of these, the Pond soils are the most extensive. Pond soils are similar to the Traver soils but have a more compact, less permeable subsoil. The Fresno and El Peco soils occupy small irregular areas. The Cajon and Hesperia soils are deep and calcareous; they occur in aggraded drain-

ageways or low, meandering stream ridges. The Cajon soils are of coarse texture, and the Hesperia soils are of moderately coarse texture. The Wunjey are deep, medium-textured, calcareous soils that normally are affected by salts and alkali. They occur mainly along the San Joaquin River, have high water-holding capacity, and are productive when reclaimed.

Unless the soils in this association are reclaimed, they are used for pasture or for gun clubs. These soils are somewhat more easily reclaimed than soils that have a hardpan. Some areas, however, contain large amounts of soluble salts or adsorbed sodium, and reclamation of these requires large amounts of gypsum, good water, and considerable time. When these soils are reclaimed, they are fairly well suited to alfalfa, cotton, field corn, and sugar beets and are well suited to irrigated pasture. Newly reclaimed soils are essentially free of many soil-borne plant diseases and pests.

Soils of the Eastside Valley Alluvial Plains

This physiographic section includes all land in the San Joaquin Valley between the basin rim and the Sierra Nevada foothills. It consists of (1) excessively drained to somewhat poorly drained soils of recent alluvial fans and flood plains, (2) somewhat excessively drained to moderately well drained soils of young alluvial fans, (3) well-drained soils of low alluvial terraces, and (4) well-drained soils of high alluvial terraces. Elevations generally range from 165 to 500 feet, but in places where this section extends along valleys into the foothills, the elevation ranges to 650 feet.

These alluvial plains consist of a sequence of deposits washed from the Sierra Nevada by rivers and streams. Many of the alluvial fans that formed coalesced into broad alluvial aprons that have gentle westerly slopes. The alluvium ranges from new deposits to deposits many hundreds of thousands of years old. The recent and young alluvial fans or aprons still retain most, and in places all, of their original form. The older alluvial fans or aprons retain little of their original shape or size. Most of the older alluvial fans were partly eroded away before the subsequent period of deposition. These older landforms are the alluvial terraces, and their form and general surface level has been controlled mainly by the rivers. The sequence of alluvial deposits of minor streams within the area has tended to conform to the more extensive alluvial areas of similar age that have been formed by the rivers.

Excessively drained to somewhat poorly drained soils of recent alluvial fans and flood plains

The areas on recent alluvial deposits are extensive and are distributed throughout the Eastside Valley Alluvial Plains. They make up about 89,000 acres, or nearly 8 percent of the survey area. Elevations range from about 156 to 650 feet. Parts of two large recent alluvial fans deposited by the Kings River and the San Joaquin River are included. These fans spread westward into the valley trough from the narrow mouths of secondary valleys cut by the rivers into the older alluvial surfaces of the San Joaquin Valley. Small fans and minor secondary flood plains have been formed by streams draining from both the Sierra Nevada foothills and older, higher lying fans or terraces in the valley. The recent flood plains and alluvial benches that are somewhat above the normal flood level are most extensive on the floor of the secondary valleys formed by the rivers. The depth of entrenchment of these valleys ranges from 10 to 100 feet. Dams on the Kings River, the San Joaquin River, and some smaller streams have greatly reduced the frequency of seasonal flooding and curbed development of these recent landforms. Two soil associations are in this subdivision.

5. Grangeville-Chino association: Deep and very deep, somewhat poorly drained sandy loams to loams

Some areas of this association are on fans and flood plains along the San Joaquin River and the Kings River, and others are along smaller streams. The soils formed in alluvium derived mainly from granitic rock. Drainage was originally somewhat poor or poor, but the pumping of ground water for irrigation has lowered the water table in these soils and improved drainage.

Grangeville soils make up about 50 percent of this association; Chino soils, about 35 percent; and minor soils, the remaining 15 percent.

The Grangeville soils formed in the slightly higher lying, somewhat better drained areas of the association. They are deep, grayish-brown, neutral to mildly alkaline soils that have a sandy loam or fine sandy loam surface layer. These soils overlie brown to pale-brown, variably mottled, slightly calcareous sandy loam to loam alluvium. The Chino soils formed in the more poorly drained areas. They are deep, gray, neutral to moderately alkaline soils that have a sandy loam to loam surface layer. These soils overlie grayish-brown, moderately alkaline loam or clay loam that is calcareous in many places. Below a depth of about 2 feet is pale, mottled, variably calcareous stratified alluvium.

Minor soils of this association are the Dello, Foster, and Tujunga and areas of the land type Riverwash. These minor soils have variable characteristics, depending on their location in the association.

About 10 percent of the acreage in this association is affected by salts and alkali, but reclamation of most of this acreage is feasible. Also, a small acreage on river bottoms near Sanger is kept saturated to a depth of 2 to 4 feet by seepage or irrigation water. This acreage is next to a small swamp.

Soils of this association that are free of salts and alkali, and those that have been reclaimed are used for growing alfalfa, cotton, corn, irrigated barley, grain sorghum, sugar beets, and irrigated pasture. Soils affected by salts and alkali are used mainly for native pasture and for irrigated pasture, but some other crops are grown. Some of the rough areas adjacent to streams have been leveled and are used for irrigated pasture. Areas not leveled are used for browse or recreation, but in some places sand and gravel are mined for use in engineering projects.

6. Hanford-Tujunga association: Deep, well-drained to excessively drained, dominantly loamy sands to fine sandy loams

The soils of this association are on benches in river

valleys and on flood plains of minor streams. They formed in recent alluvium derived mainly from granitic rock. Construction of small dams has controlled some of the small streams and has lessened the hazard of seasonal flooding.

Hanford soils make up about 70 percent of this association; Tujunga soils, about 15 percent; and minor soils, the remaining 15 percent.

The Hanford soils are deep, permeable, light brown or pale brown, and are neutral in reaction. They range from coarse sandy loam to fine sandy loam in texture. In places Hanford soils are underlain by loose gravel, by a sandy substratum, or by an older soil at a depth of more than 30 inches.

The Tujunga soils are paler in color than the Hanford soils and are coarser textured. Their texture ranges from loamy coarse sand to sand that is gravelly or cobbly in places. Tujunga soils are deep, are very permeable, and have low water-holding capacity. They generally occupy small, irregular shaped areas or narrow, branching areas on stream ridges or in aggraded channels on the upstream part of the flood plains.

Minor soils of this association are the Atwater, Delhi, Exeter, Greenfield, Nord, and Visalia and the land type Riverwash. The Visalia soils are near Orange Cove and north of Clovis, near Hanford soils. Nord soils are northeast of Centerville along Holland Creek, and Riverwash is near Piedra and along the San Joaquin River. The other minor soils occur at random throughout the association.

The Hanford soils are well suited to irrigated alfalfa, cotton, field corn, table grapes, wine grapes, raisin grapes, peaches, and plums. The low water-holding capacity of the Tujunga soils limits their use for field crops and for tree fruit crops. If irrigation water is applied and if other good management is used, the Tujunga soils are suited to vineyards. Where irrigation water is not available, the soils in this association are used for grazing or browse.

Somewhat excessively drained to moderately well drained soils of young alluvial fans

A sequence of deposits washed mostly from granitic rock in the Sierra Nevada Mountains by rivers and streams have formed the young alluvial fans in this physiographic section. This subdivision makes up about 359,586 acres, or nearly 27½ percent of the survey area. Elevations range from about 200 to 450 feet. Large areas of soils on young alluvial fans of the San Joaquin River and the Kings River are west and south of the city of Fresno. Soil material deposited by Dry Creek, by Fancher Creek, and by other small streams coalesced and formed an irregularly shaped part of the area east and northeast of Fresno and Clovis. A similar area formed near Reedley and Orange Cove. Entrenchment of the rivers and streams has lessened the flood hazard.

Soils of this subdivision are generally well drained, but minor areas are moderately well drained to poorly drained. Some soils near the basin rim or in poorly drained areas are affected by salts and alkali. Four soil associations are in this subdivision.

7. Hanford-Hesperia association: Well-drained sandy loams and fine sandy loams that are moderately deep or deep to compact silt

A large part of this association is south of the San Joaquin River and extends from the terraces near Herndon to the basin rim west of Kerman. A smaller area is northeast of Pinedale.

The Hanford and Hesperia soils each make up about 45 percent of this association; the remaining 10 percent consists of Tujunga soils.

These gently sloping soils are on young alluvial fans and are part of an area known locally as "white ash lands." The slope is in a southwesterly direction, and the drop ranges from 4 to 10 feet per mile. Throughout the area ground water is at a depth near 40 feet (7). Under natural conditions the water table is closer to the surface in the western and southwestern parts of the association and the soils are not so well drained as in the eastern part.

The Hanford soils occupy fairly large areas throughout the association, but the largest areas are in the eastern half. They are mainly light brownish gray. These soils are neutral in reaction and have a surface layer of sandy loam or fine sandy loam. They overlie unconforming compact layers of light-gray silt or silt loam at a depth of 2 to 4 feet. The compact layers do not seriously restrict penetration of roots and water. The largest areas are made up of Hanford soils that have a silty substratum. Crossing these areas in a southwesterly direction are deep, narrow areas of Hanford coarse sandy loam and of Tujunga loamy sand.

The Hesperia soils are similar to Hanford soils, but they have a subsurface layer that is slightly to moderately calcareous and overlies compact silty material. Most of the Hesperia soils are in the lower, western part of the fans, and some are saline-alkali affected but can easily be reclaimed. The areas are crossed by deep, narrow, coarser textured Hanford and Tujunga soils and by winding areas of Hesperia coarse sandy loam.

Most areas of this association are irrigated and are used to grow table and raisin grapes, plums, and peaches. Alfalfa, cotton, and field corn are grown in some places. Except for small areas of coarser textured, included soils, the soils in this association are among the most productive in California.

8. Hanford-Delhi-Hesperia association: Deep, somewhat excessively drained and well-drained sands to fine sandy loams; partly wind modified

The soils in this association occupy most of the young alluvial fan of the Kings River, and also a small area near Reedley.

The Hanford, Delhi, and Hesperia soils each make up slightly less than one-third of the association; the remainder is made up of Dello and Tujunga soils. The slope of the young fan is 4 to 10 feet per mile in a southwest direction from Sanger. These soils have a rougher, more uneven surface than the soils of association 7 on the young fan of the San Joaquin River. The remnants of at least four large, dry channelways dissect this soil association. They are part of a former

flood distributary system of the Kings River. Parts of these remnants are filled with coarse sandy alluvium. Wind deposited material has blocked unfilled parts of these channelways and formed closed depressions. Other depressions were formed by wind scouring. In large areas the wind has piled the sandy soil material into undulating or rolling relief. The soils in this association generally are somewhat excessively drained and well drained, except in the depressional areas where drainage is somewhat poor or poor.

In this association the areas of Hanford and Hesperia soils, are like those in association 7, but the minor Tujunga soils are wider and more extensive. The Hanford and Hesperia soils laid down by streams in a southwesterly direction, and the Delhi and Dello soils, laid down by wind in a northwest to southeast direction, occur in a rough checkerboard pattern.

The Hanford soils are mainly light brownish gray. These soils are neutral in reaction and have a surface layer of sandy loam or fine sandy loam. They overlie unconforming compact layers of light gray silt or silt loam at a depth of 2 to 4 feet. The compact layers do not seriously restrict penetration of roots and water. The largest areas are made up of Hanford soils that have a silty substratum. Crossing these areas in a southwesterly direction are deep, narrow areas of Hanford coarse sandy loam and of Tujunga loamy sand.

The Delhi soils are deep, pale-brown, neutral sand or loamy sand that in places overlie a compact silty layer at a depth of more than 3 feet. Their water-holding capacity is low. The Dello soils occupy the depressional areas and have a surface layer of grayish-brown, neutral loamy sand. The wind-formed patterns are not so strongly developed in areas east of U.S. Highway 99 as in other parts of the association. Saline-alkali affected areas of the Hesperia and Dello soils are near the basin rim in the western part of the association.

The Hesperia soils are similar to Hanford soils, but they have a subsurface layer that is slightly to moderately calcareous and overlies compact silty material. Most of the Hesperia soils are in the lower, western part of the fans, and some are saline-alkali affected but can easily be reclaimed. The areas are crossed by deep, narrow, coarser textured Hanford and Tujunga soils and by winding areas of Hesperia coarse sandy loam.

Most areas of this association are used to grow table and raisin grapes and such tree fruit crops as peaches and plums. Orchards are scattered over the eastern two-thirds of the association, and they are surrounded by extensive vineyards from which grapes are harvested for raisins or for crushing. Delhi and Tujunga soils are used for raisin grape vineyards. Cotton, alfalfa, and field corn are grown in the western part of the association.

9. Pachappa-Hesperia association: Well drained and moderately well drained fine sandy loams or loams that are moderately deep or deep to compact silt

Soils of this association are on young fans along Fancher Creek and Dry Creek. They are browner than adjoining similar soils on young fans of the rivers. The surface layer is commonly loam to fine sandy loam. The alluvium from both creeks was deposited along a very gently depressed area marking the confluence of the young fan deposits from the rivers. In the western part of this association, southwest of Kearney Park, are soils that are somewhat saline-alkali affected.

Pachappa soils make up about 60 percent of this association; Hesperia soils, about 25 percent; and minor soils, about 15 percent.

The Pachappa soils are brown to grayish brown. They have a loam surface layer that overlies a brown, slightly compact and slightly finer textured clay loam subsoil. The subsoil is slightly calcareous and slightly restricts penetration of roots and water. Somewhat more permeable alluvium is at a depth below about 40 inches. In places the substratum is light-brown or light-gray, compact, silty material that is not cemented and does not seriously restrict internal drainage. In some areas of the Pachappa soils, the water table formerly was near the surface and salts and alkali accumulated in the soil. Many of these areas have been reclaimed since the water table has been lowered.

The Hesperia soils are light brownish gray coarse sandy loam to sandy loam, and have a subsurface layer that is slightly to moderately calcareous and overlies compact silty material. Most of the Hesperia soils are in the lower, western part of the fans, and some are saline-alkali affected but can easily be reclaimed. The areas are crossed by deep, narrow, coarser textured Hanford and Tujunga soils and by winding areas of Hesperia coarse sandy loam.

Minor soils of this association are the Borden, Delhi, El Peco, Hanford, and Tujunga. The Hanford are the most extensive and make up as much as 10 percent of the association.

The crops grown on the soils of this association are similar to those grown on the soils of the Hanford-Hesperia association. A larger acreage, however, is in such field crops as cotton, alfalfa, and grain sorghum. The saline-alkali areas that are being reclaimed are poorly suited to fairly well suited to alfalfa, cotton, and irrigated pasture. Unreclaimed areas are used for alkali pasture.

10. Greenfield-Atwater association: Well-drained loamy sands and sandy loams that are moderately deep or deep to compact sandy material, partly wind modified

Some soils in this association are on young alluvial plains formed by deposits from small streams that drained the Sierra Nevada foothills. Others are on wind laid material blown from the sandier alluvial areas and from dry channels by prevailing northwesterly winds. The winds laid the material down only a short distance from its source as a sandy mantle of varying thickness in a large, undulating area, or as low fingerlike ridges oriented with the prevailing direction of the wind. The Greenfield soils formed on stratified alluvial material, and the Atwater soils on the more uniformly sorted, wind-laid material.

The Greenfield and Atwater soils are nearly equal in extent, and together they make up about 95 percent of this association. The remaining 5 percent consists of minor soils.

The Greenfield soils are brown to pale brown, generally are neutral in reaction, and have a sandy loam surface layer. The subsoil is brown or yellowish-brown, slightly finer textured, and slightly more compact material than that in the surface layer. The Atwater soils are like the Greenfield soils but are undulating to rolling. Their surface layer ranges from loamy sand to sandy loam and is somewhat grayer than that in the Greenfield soils. The subsoil is somewhat finer textured than the surface layer, and in places it consists of several layers separated by material like the surface layer. In some places both soils are deep, but in large areas they are moderately deep over compact, weakly cemented, slowly permeable, sandy material.

Minor soils of this association are Delhi, Hanford, and Tujunga. Small areas of Delhi loamy sand are near the Atwater soils, and a few narrow areas of Hanford and Tujunga soils cross larger areas of Greenfield soils.

The deeper soils in this association are used to grow peaches, plums, and grapes for table, wine, and raisin use. Citrus is grown in the eastern part of the San Joaquin Valley where there is less frost hazard. Cotton and alfalfa are also grown. Deep-rooted orchard crops are not so well suited to the moderately deep soils. The coarser textured Atwater soils are well suited to raisin or wine grapes, but are not so well suited to field crops.

Well-drained soils of low alluvial terraces

Remnants of old fans of the rivers and streams occur as alluvial terraces well above the streams from which they were deposited. They are above the streams because of a minor uplift of the area some time ago, the entrenchment of the rivers and streams, and the washing away of part of the area. This subdivision makes up about 151,400 acres, or nearly 14 percent of the survey area. Elevations range from about 250 to 550 feet. Prominent terrace escarpments border the secondary valleys of the rivers. Less prominent escarpments border the contact of the terraces with fans formed from more recent alluvium. In places, young alluvium fills embayments along the edges of the terraces, and in other places it covers eroded parts of the terraces and obscures their boundaries.

The alluvial material in low terraces came from a variety of rocks. The terraces near the rivers consist mainly of material from granitic rock. The terraces near smaller streams consist of a mixture of material derived mainly from gabbro or from metamorphic volcanic rock.

In some places water is seasonally ponded in depressions. In other large areas runoff is slow to rapid, and drainage varies accordingly. Two soil associations are in this subdivision.

11. San Joaquin-Exeter-Ramona association: Sandy loams to loams that are shallow or moderately deep to a hardpan and deep sandy loams and loams

Most soils of this association have a hardpan that is cemented with iron and silica. The hardpan occurs at a depth of 12 to 48 inches and is impermeable to roots and water. If the hardpan is not broken, the soils are waterlogged, both in wet years and when overirrigated. In dry years crops are likely to be damaged by drought. The soils that have a hardpan are the San Joaquin, Exeter, and Madera. The Ramona soils have a moderately restrictive subsoil but lack a hardpan. Some of the Ramona soils, however, have a compact sandy substratum at a depth of 3 to 4 feet. The substratum restricts penetration of roots and water, but not so much as a hardpan. All soils in this association formed in material from old granitic alluvium.

The San Joaquin soils make up about 50 percent of this association; the Exeter soils, about 25 percent; and the Ramona soils, about 20 percent. The remaining 5 percent is minor soils.

The San Joaquin soils have a surface layer of brown to reddish-brown, slightly acid to medium acid loam to sandy loam. They have a thin clay subsoil, about 8 inches thick, that rests abruptly on a cemented hardpan at a depth of 18 to 36 inches. The hardpan is 6 to 24 inches thick and overlies sandy or silty material.

The Exeter soils are similar to the San Joaquin soils, but have a brown, slightly acid to neutral surface layer. Their subsoil is brown or yellowish brown and is slightly finer textured than the surface layer.

The Ramona soils are widely distributed in the association within larger areas of hardpan soils. They have a surface layer of brown to light-brown, slightly acid to neutral sandy loam to loam. Their subsoil is thick, reddish-brown, neutral sandy clay loam or clay loam. It overlies coarse parent alluvium or older unrelated compact sandy material.

Minor soils of this association are Cometa, Madera, Montpellier, and Pollasky. The Madera soils are on the lower part of the terraces, near Fresno and Orange Cove. The texture of their surface layer is similar to that of the San Joaquin soil, but it is brown and neutral in reaction. The Cometa, Montpellier and Pollasky soils occupy naturally eroded, hilly to undulating borders of the terraces.

Soils in this association that are not irrigated are used for dryfarmed barley. Irrigation water is available for most areas from surface canals, or from wells that are 30 to 70 feet deep. After deep ripping the hardpan and leveling the surface, the soils are suited to cotton, grain sorghum, sugar beets, orchard crops, and vineyards. The soils near the foothills are in groves of citrus. A large part of the San Joaquin and Exeter soils is used for figs grown chiefly for the dried fruit industry. Most of the acreage in figs consists of old plantings in areas where the hardpan was blasted before each tree was planted. The Exeter soils are well suited to table grapes, but the Ramona soils are suited to deeper rooted crops. Good to very good irrigated pastures have also been developed.

12. Academy-Yokohl association: Loams that are moderately deep to a compact layer and soils of similar texture that are shallow to a cemented hardpan

Soils of this association are on dissected low terraces. They formed in old alluvium derived mainly from gabbro and metamorphic basic igneous rocks. Subsequent dissection of these stream terraces pro-

duced areas of soils that were undulating to gently rolling. The Academy soils formed in the material exposed. The Yokohl soils, on crests of knolls and low ridges, have a hardpan and are remnants of more extensive areas of soil that had formed on the original surface of the terraces.

The Academy soils make up about 60 percent of this association; the Yokohl soils, about 35 percent; and the minor soils, the remaining 5 percent.

Academy soils have a surface layer of dark-brown, slightly acid loam. Their subsoil is dense, blocky clay loam that is neutral to mildly alkaline. The subsoil grades fairly abruptly into old, compact, sandy sediment many feet thick. Depth to the sediment ranges from about 2 to 3 feet.

Yokohl soils have a surface layer of reddish-brown, slightly acid loam to clay loam that in a few places is gravelly. Their subsoil is dense, reddish-brown clay that has prismatic structure. It ranges from slightly acid to mildly alkaline, and rests abruptly on a strongly cemented hardpan at a depth of 1 to 2 feet. The hardpan is cemented by iron oxides, silica, and lime, and it seriously restricts penetration of roots and water.

Minor soils of this association are the Alamo, Centerville, and Hildreth. The Alamo soils are dark-colored clay and have a hardpan; they occupy minor depressions within areas of Yokohl soils. Centerville clay is near Round Mountain. The Hildreth soils consist of dark-colored clay and occupy many swales that drain areas of this association.

Most of this association is above the level of the irrigation canals, and the supply of ground water is limited. The soils therefore are used mainly for range and for dryfarmed barley. Some areas, however, are used for citrus, and other areas are used for residential development.

Well-drained soils of high alluvial terraces

Small areas of alluvium, older than the low terraces, are on both sides of the San Joaquin and Kings Rivers close to the entrance to their canyons at the edge of the Sierra Nevada Foothills. This subdivision makes up about 5,570 acres, or about 0.5 percent of the survey area. Elevations mostly range from 450 to 900 feet, though in small areas the elevation is as high as 1,200 feet.

These terraces are all that remain of the more extensive fan deposits made up of mixed alluvium that is cobbly or gravelly in many places. They are called high alluvial terraces, because their relative position is above other alluvial deposits in the San Joaquin Valley. The high terrace remnant north of Centerville is the best preserved part of this old landform. Excavations show that these older materials were deposited on older weathered bedrock. Two soil associations are in this subdivision.

13. Centerville-Keyes association: Clays that are moderately deep to compact sandy material and cobbly clay loams that are shallow to a cemented hardpan

Soils of this association are on high terraces near Centerville and Tivy Valley. These soils formed from a mixture of old deposits of feldspar sand that weather readily and of cobblestones and pebbles that resist weathering.

Centerville soils make up about 75 percent of this association; the Keyes soils, about 20 percent; and minor soils, the remaining 5 percent.

The Centerville soils consist of dark reddish-gray clay and cobbly clay that in many places have lime nodules in the subsurface layer. These soils overlie compact sandy material that is mostly cobbly and is limy in places. Centerville soils are 2 to 3½ feet deep.

The Keyes soils have a surface layer of dark grayish-brown cobbly clay loam. Their subsoil, a dense cobbly clay, rests on a reddish or yellowish, cobbly, cemented hardpan at a depth of 1 to 2 feet.

Minor soils of this association are in the Redding and Porterville Series. The Redding soils have a reddish, cobbly or gravelly hardpan. Small areas of Porterville soils that are cobbly in places are near the Centerville soils.

Much of this association is used for range. Growth of forage plants is fair to good and is best on the clay soils. Where irrigation water is available, orange groves have been planted, generally on soils that are free of cobblestones. The relatively high position occupied by the soils of this association makes the areas suitable for tree fruit because air drainage is good and the frost hazard is less than in low-lying areas.

14. Positas-Redding association: Gravelly loams that are moderately deep to a compact layer or a cemented hardpan

Soils of this association are near the town of Friant and near Tivy Valley. They formed on eroded high terraces from mixed gravelly or sandy material. The material was deposited by ancient rivers whose channels have long since been obliterated.

The Positas soils make up about 65 percent of this association, and the Redding soils, the remaining 35 percent.

Positas soils have a surface layer of brown to grayish brown, acid gravelly loam. The subsoil is reddish-brown, medium acid to slightly acid clay that contains a variable amount of gravel and cobblestones. It is underlain at a depth of 2 to 3 feet by gravelly or cobbly loam that is many feet thick.

Redding soils have a surface layer of reddish-brown, acid gravelly loam. The subsoil is dark reddish-brown, strongly acid clay. It rests abruptly on a gravelly hardpan. Depth to the strongly cemented hardpan is 1 to 3 feet. The hardpan is underlain by thick beds of gravelly material.

The soils of this association are poorly suited to irrigated or dryfarmed crops and are used for range. Local sources of water are limited, though some is available for livestock.

Soils of the Uplands of the Sierra Nevada Foothills

This section includes that part of the Sierra Nevada foothills that comprises the eastern quarter of the survey area. It consists of (1) excessively drained to well-drained soils of the lower foothills and (2) somewhat excessively drained and well-drained soils

of the upper foothills. The soils in this section formed mainly from granitic, metamorphic, serpentine, and basic igneous rocks. Small areas formed on colluvium, and many small valleys formed on local alluvium.

The foothills extend to the east from the edge of the San Joaquin Valley. Relief ranges from undulating to very steep, and elevation increases to the east. Except where canyons have been cut, the soils formed in material from granitic rock tend to have smoother, less steep slopes than the other soils. The areas derived from metamorphic, serpentine, or basic igneous rocks generally have rougher, steeper slopes.

The uplands of the Sierra Nevada foothills are not divided physiographically, but are divided on the basis of climate into the lower and upper Sierra Nevada foothills. The gradual increase in average annual precipitation and decrease in average annual temperature is closely related to the increase in elevation. The lower foothill area is warmer and drier than the upper foothill area.

Excessively drained to well-drained soils of the lower foothills

The soils of the lower foothills formed in material weathered from several different kinds of rock. They make up about 186,000 acres, or nearly 17 percent of the survey area. This part of the foothills extends from the eastern edge of the San Joaquin Valley where the elevation is about 500 feet to areas where the elevation is about 3,000 feet. The upper boundary is determined by the elevation, shape, and aspect of the land surface which, in turn, controls the local climate and local development of the soils.

The average annual precipitation ranges from about 14 inches to about 20 inches, and the average annual temperature decreases with increases in elevation from 62° to 58° F.

Most of the soils in the lower foothills have an open to very open cover of annual grasses and forbs. Trees and shrubs grow in places, though they are not dominant in the natural vegetation. Nearly all of the soils are used for range, but some are used for watershed purposes and as habitat for wildlife. The areas also have some recreational and esthetic value. Four soil associations are in the lower foothills.

15. Vista-Fallbrook association: Well-drained sandy loams that are shallow to moderately deep over granitic rock

The soils of this association have formed mainly from granitic rock, principally quartz diorite (*14*). They vary in content of iron bearing minerals. The topography ranges from rolling to hilly areas that have some outcrops of rock to steep, rocky areas.

Vista soils make up about 60 percent of this association; Fallbrook soils, about 30 percent; and minor soils, about 10 percent.

The Vista soils have a surface layer of pale-brown, neutral to slightly acid coarse sandy loam that is massive and hard when dry. The subsoil is weakly developed. It consists of brown to pale-brown, slightly acid coarse sandy loam that is massive or has weak structure when dry and grades abruptly to weathered parent rock. Depth to weathered parent rock ranges from 1 to 3 feet.

The Fallbrook soils generally are somewhat deeper, are redder in color, and have a more strongly developed subsoil than the Vista soils. The surface layer is similar to that of the Vista soils, but it is brown in color and in places is sandy loam. The subsoil is reddish-brown, blocky sandy clay loam or clay loam that is neutral to slightly acid. It is underlain by weathered parent rock that generally contains more dark-colored, iron bearing minerals than the material from which Vista soils formed.

Minor soils of this association are the Friant, Sesame, Hanford, Visalia, Grangeville, and Foster soils, and areas of the land type Granitic rock land. The Friant and Sesame soils are north of the Kings River. Friant soils are shallow, brown fine sandy loams that formed from quartz mica schist. The gently sloping Sesame soils have a dark brown sandy loam surface layer, and a dense, brown sandy clay loam subsoil. They formed from quartz diorite. The Hanford, Visalia, Grangeville, and Foster soils are on alluvium in narrow, small stream valleys.

The soils in this association are used mainly for range. Forage yields are good in years of favorable moisture and poor in years of unfavorable moisture. Citrus is grown in areas where irrigation water is available and where the frost hazard is low.

16. Blasingame-Millerton-Tivy association: Well-drained and somewhat excessively drained fine sandy loams to clay loams that are over basic igneous rock

The soils of this association formed chiefly in material from gabbroid or metamorphosed volcanic rock, such as hornblende gabbro and diorite or plagioclase amphibolite (*14*). These soils are somewhat darker colored, somewhat finer textured, and generally are more hilly and steeper than the soils of the Vista-Fallbrook association. These differences in soil characteristics reflect differences in the parent rocks. Low irregularly shaped outcroppings of rock make up about one-third of each soil area.

The Blasingame soils make up about 50 percent of this association; the Millerton soils, about 25 percent; Tivy soils, about 20 percent; and minor soils, the remaining 5 percent.

Blasingame soils have a surface layer of brown to reddish-brown, neutral or slightly acid loam to clay loam. The subsoil is thick, reddish-brown, neutral to mildly alkaline clay loam that is moderately permeable. Well-weathered parent rock is at a depth of 2 to 4 feet.

The Millerton soils are typically shallow to weathered parent rock. Their surface layer is fine sandy loam, but it otherwise is similar to that in the Blasingame soils. It is massive and is hard when dry. The subsoil is thin and rests directly on slightly weathered parent rock. The subsoil is reddish-brown fine sandy loam to loam that is massive or has weak blocky structure.

Tivy soils have a surface layer of dark brown to grayish-brown, neutral or slightly acid loam that is massive and is hard when dry. The subsoil is weakly developed. The texture is slightly finer than that of

the surface layer, and the structure is weak subangular blocky. Reaction is similar to that of the surface layer. Weathered parent rock is at a depth of 10 to 30 inches.

Minor soils of this association are the Honcut and Los Robles, and small areas of metamorphic rock land. The Honcut and Los Robles soils are in small stream valleys. Dense woody vegetation covers some areas at the higher elevations.

These soils are used for range. During years of favorable moisture, forage yields are good to very good. Forage yields are poor during years of unfavorable moisture, though they are somewhat better than on soils formed in material from granitic rock.

17. **Cibo-Porterville association: Well-drained and somewhat excessively drained clays that are moderately deep to deep over basic igneous rock and permeable sediment**

Soils of this association formed from basic igneous rocks that weathered readily. They are clay in texture. The areas are along the lower edge of the foothills or are on outliers of the foothills surrounded by alluvial material of the San Joaquin Valley.

Cibo soils make up about 50 percent of this association; Porterville soils, about 45 percent; and Mt. Olive soils, the remaining 5 percent.

The Cibo soils are undulating to very steep and are very rocky or extremely rocky. They consist of dark grayish-brown to dark-gray, blocky clay. Deep, wide cracks tend to form in the Cibo soils upon drying. The surface layer is neutral, but the reaction becomes more alkaline with depth. In a few places lime accumulations occur in the lower part of the weathered parent rock. Depth to weathered rock ranges from 20 to 60 inches. Fragments of stone are common throughout the soil.

Porterville soils formed in the colluvium that surrounds most of the knolls, hills, or ridges on which the Cibo or Mt. Olive soils formed. Porterville soils are nearly level to sloping. These deep soils consist of dark reddish-brown, fine clay that is granular or blocky and has accumulations of lime deep in their profile. Some areas are cobbly or gravelly, and some contain coarse rock fragments.

Mt. Olive soils are undulating to rolling and are free of rocks. They consist of grayish-brown, granular, highly calcareous clay that grades to marllike weathered material at a depth of 30 to 40 inches. The weathered material is from rocks similar to the rocks from which the Cibo soils formed.

This association is used mostly for range. Forage yields are very good in years of favorable moisture and poor in years of unfavorable moisture. Where irrigation water is available, the frost hazard is low and the soils are free of rocks and cobblestones. Early tomatoes and citrus are grown on areas of Porterville and Mt. Olive soils. Some gently sloping, rock-free areas of Cibo soils are used for dryfarmed grain.

18. **Fancher-Delpiedra association: Well-drained to excessively drained loams that are shallow to moderately deep over serpentine rock**

The soils of this association formed in material from altered serpentine rock. The proportion of magnesium to calcium is lower in these soils than in other soils formed from similar parent rock. Considerable colluvial creep of soil material is common. These steep to very steep soils occur on ridges and hills.

Fancher soils make up 75 percent of this association, and Delpiedra soils, 25 percent. Included in this association are several landslide areas.

The Fancher soils are moderately deep and are stony. The surface layer is reddish, neutral loam, and the subsoil is dense, gravelly clay. At a depth of more than 25 inches the subsoil rests on well-weathered serpentine rock.

The Delpiedra soils are thin and stony. Their surface layer is reddish, neutral loam, and their subsoil is dark reddish-brown or yellowish-red heavy loam or clay loam that is also neutral. At a depth of 20 inches or less, the subsoil rests on well-fragmented, weathered serpentine rock.

These soils are used entirely for range. Production of forage is fair in years of favorable moisture and poor in years when rainfall is low or is poorly distributed throughout the growing season. These soils are not so fertile as nearby foothill soils, but they produce more grass than other soils on serpentine rock. Annual grasses, forbs, and some clusters of perennial grasses grow on most areas of these soils. Oaks and shrubs grow on some protected slopes at higher elevations.

Somewhat excessively drained and well-drained soils of the upper foothills

The soils in the upper foothills formed in material weathered from rocks similar to those in the lower foothills, except that no serpentine rock is in the area. The upper foothills make up about 138,000 acres, or nearly 17 percent of the survey area. The lower boundary is not sharply defined and is dependent upon aspect or the protective influence of prominent outlying hills or ridges in the lower foothills (fig. 2). An isolated area of the upper foothills is on the north side of a large ridge near the entrance to Kings River Canyon. Soils typical of the upper foothills at elevations much lower than normal are on the canyon slopes of both the Kings and San Joaquin Rivers. The upper foothill zone joins the middle mountain conifer forests beyond the eastern boundary of the survey area. A few middle mountain soils are included, however, in the upper foothills.

The elevation ranges from about 1,500 to about 4,000 feet. The average annual precipitation ranges from about 20 inches at the lowest elevations to 35 inches at the highest elevations in the southeastern corner of the survey area. The average annual temperature decreases as elevation increases and ranges from 59° to 53° F.

The soils in the upper foothills differ in some respects from those in the lower foothills because they formed under a cooler, more moist climate. The upper foothill soils are somewhat more leached, generally are deeper, and have more organic matter in their

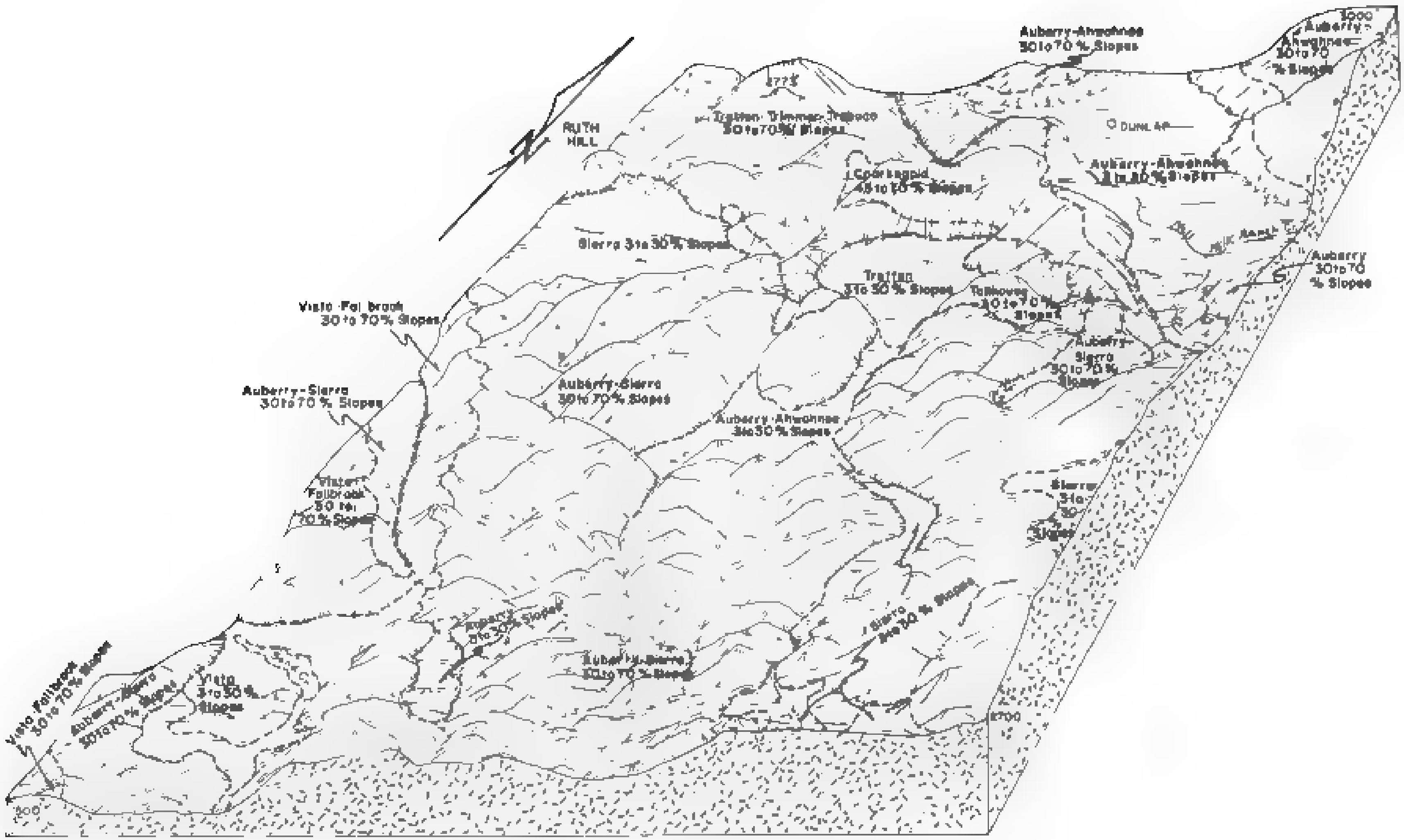

Figure 2.—Relationship of some important soil series on lower and upper foothills to the landscape.

surface layer. Also, structure of the surface layer is granular instead of massive.

These soils are used for range, watershed, wildlife habitat, recreation, and residences. The vegetation is mainly wood and grass, woodland shrub, and dense chaparral. Three soil associations are in the upper foothills.

19. Auberry-Ahwahnee association: Well-drained and somewhat excessively drained sandy loams that are moderately deep and deep over granitic rock

The soils in this association formed in material from granitic rock, mainly quartz diorite (*14*). These soils occur on rocky ridges or canyon slopes. Some areas are rolling to hilly, and others are steep to very steep. In places rocks crop out.

Auberry soils make up about 60 percent of this association; Ahwahnee soils, about 20 percent; and minor soils, the remaining 20 percent.

The surface layer of the Auberry soils is grayish-brown, slightly acid to coarse sandy loam that has granular structure. The subsoil is thick brown to yellowish-brown medium acid sandy clay loam that has angular blocky structure. The subsoil restricts penetration of roots and water.

Ahwahnee soils have a surface layer of grayish-brown, slightly acid coarse sandy loam that has granular structure. The subsoil is brown to pale-brown, slightly acid to medium acid coarse sandy loam that has subangular blocky structure. Small amounts of clay have accumulated in the subsoil.

Minor soils in this association are the Sierra, Visalia, Tollhouse, Holland, and Shaver soils, and the land type Granitic rock land. The soils occur together in a complex pattern or separately in large areas. The Sierra soils are the most extensive minor soils, and they make up about 15 percent of the association. They are mainly in the highlands south of Dunlap. These soils formed in material from quartz diorite and have a high content of iron bearing minerals. They have a surface layer of brown to grayish brown, slightly acid, granular sandy loam. The subsoil is thick, reddish-brown, slightly acid clay loam. Well-weathered parent rock is at a depth of 3 to 6 feet. The Tollhouse soils are very steep. The Visalia soils formed in local alluvium in small stream valleys. Holland and Shaver soils occur with the Sierra soils but have a cover of conifer forest.

The soils in this association are used mainly for grazing. Forage production is very good in years of favorable moisture and fair in years of unfavorable moisture. On limited areas of the gently sloping soils, woodland-shrub or chaparral is being converted to dryland pasture or dryfarmed grain-hay. Irrigated pasture has been developed where water is available. Many turkey farms are in this association. Most residential development in the upper foothills is in this association.

20. Coarsegold association: Somewhat excessively drained fine sandy loams that are deep over metasedimentary rock

Soils of this association formed in material from metamorphosed sedimentary rock, mainly quartz mica schist (*14*).

Coarsegold soils make up almost all of this association. Small areas consist of Ahwahnee and Trimmer soils and outcrops of metamorphic rock.

Coarsegold soils commonly have slopes of more than 45 percent. The surface layer is brown, slightly acid, micaceous fine sandy loam. It has weak granular structure or is massive. The subsoil is thick, reddish-brown, slightly acid clay loam that is micaceous and has blocky structure. Well-weathered quartz mica schist is at a depth of more than 36 inches.

These soils are used chiefly for range in spring, because the steep slopes provide too poor footing for livestock during other seasons. Forage production is very good in years of favorable moisture and good in years of unfavorable moisture. Areas of these soils are good for small watersheds.

21. Trimmer-Trabuco association: Well-drained and somewhat excessively drained sandy loams to loams that are moderately deep and deep over basic igneous rock

Soils of this association formed in material from metamorphic volcanic rocks and other basic igneous rocks, mainly plagioclase amphibolite, metadiorite, and diorite (*14*). They are steep to very steep and occur on hills and ridges. Many of the areas are very rocky. The natural vegetation ranges from woodland-grass to dense chaparral.

Trimmer soils make up about 50 percent of this association; Trabuco soils, about 25 percent; and minor soils, the remaining 25 percent.

Trimmer soils have a surface layer of grayish-brown, slightly acid, granular loam. The subsoil is reddish-brown, neutral to slightly acid clay loam. It is moderately permeable and commonly has angular blocky structure. Deeply weathered parent rock is at a depth of about 24 to 36 inches.

The Trabuco soils have a surface layer of brown to grayish-brown, slightly acid loam that generally is granular in the upper part. It abruptly overlies a dark reddish brown, neutral clay subsoil that is dense and slowly permeable. Deeply weathered parent rock is at a depth of about 30 to 70 inches.

Minor soils of this association are Tretten, Wisheylu, Hideaway, Toomes, Aiken, and Keefers soils and the miscellaneous land type Basic igneous rock land. The Tretten soils are the most extensive minor soils and make up about 16 percent of the association. They are similar to the Trimmer soils, but have a thicker surface layer of granular fine sandy loam and a weakly developed, brown subsoil that is slightly finer textured than the surface layer. Large areas of the Trimmer and Tretten soils have been mapped as a complex. The Wisheylu soils are similar to the Trabuco soils, but have a dull-brown or grayish-brown clay subsoil. The Hideaway, Toomes, and Aiken soils formed on basalt flows or on mud flows of basaltic material. The Hideaway and Toomes soils are shallow and are in the warmer, drier parts of the upper foothills. The Aiken soils are deep and are in a small forested area. The Keefers soils formed in stony or cobbly colluvium south of the Kings River.

Soils of this association are used for range. Forage production is very good in years of favorable moisture, and good in years of unfavorable moisture. Converting areas of brush to range is a good way to gain valuable grazing areas. These soils have high value for use as watershed areas.

Descriptions of the Soils

This section describes the soil series and the mapping units in the Eastern Fresno Area. The procedure is first to describe each soil series, and then to describe the mapping units in that series. Thus, to get full information on any one mapping unit, it is necessary to read the description of that unit and the description of the soil series to which it belongs.

The soil series contains a brief description of a soil profile, the major layers from the surface downward. This profile is considered typical for all the soils of the series. If the profile for a given mapping unit differs from this typical profile, the differences are stated in the description of the mapping unit, unless the differences are apparent in the name of the mapping unit.

As mentioned in the section "How This Survey Was Made" not all mapping units are members of a soil series. Basic igneous rock land, for example, does not belong to a soil series, but nevertheless, is listed in alphabetical order along with the soil series.

Following the name of each mapping unit, there is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description is the capability unit and the range site in which the mapping unit has been placed. The pages on which each capability unit and each range site are described can be learned by referring to the "Guide to Mapping Units" at the back of this publication. The acreage and proportionate extent of the mapping units are shown in table 1.

TABLE 1.—*Approximate acreage and proportionate extent of the soils of the Eastern Fresno Area*

Soil	Area	Extent
	Acres	*Percent*
Academy loam, 0 to 3 percent slopes	[illegible]	(1)
Academy [illegible] to [illegible] percent slopes	5,610	[illegible]
Ahwahnee coarse sandy loam, 3 to 9 percent slopes	362	(1)
Ahwahnee coarse sandy loam, 9 to 15 percent slopes	3,644	[illegible]
Ahwahnee coarse sandy loam, 15 to 30 percent slopes	2,[illegible]	.2
Ahwahnee coarse sandy loam, 30 to 45 percent slopes	1,249	.1
Ahwahnee very rocky coarse sandy loam, 3 to 30 percent slopes	1,701	.2
Ahwahnee very rocky coarse sandy loam, 30 to 45 percent slopes	3,233	.3
Ahwahnee very rocky coarse sandy loam, 45 to 70 percent slopes	2,[illegible]	.2
Ahwahnee very rocky coarse sandy loam, shallow, 3 to 30 percent slopes	416	(1)
Ahwahnee very rocky coarse sandy loam, shallow, 30 to 70 percent slopes	4,246	.4
Ahwahnee-Sierra coarse sandy loams, 15 to 30 percent slopes	795	[illegible]
Ahwahnee-Sierra coarse sandy loams, [illegible] 45 percent slopes	268	(1)
Ahwahnee-Toomes-Rock land complex, 45 to 70 percent slopes	[illegible]	.1
Aiken loam, 3 to 9 percent slopes	[illegible]	(1)
Aiken very rocky loam, 45 to 70 percent slopes	[illegible]	(1)
Alamo clay	2,534	.2
Atwater loamy sand, 0 to 3 percent slopes	5,969	.5
Atwater loamy sand, 3 to 9 percent slopes	786	.1
Atwater loamy sand, moderately deep, 0 to 3 percent slopes	[illegible]	(1)
Atwater sandy loam, 0 to 3 percent slopes	[illegible]	1.0
Atwater sandy loam, 3 to 9 percent slopes	[illegible]	.1
Atwater sandy loam, clay substratum, 0 to 3 percent slopes	798	.1
Atwater sandy loam, moderately deep, 0 to 3 percent slopes	4,954	.4
Auberry coarse sandy loam, 3 to 9 percent slopes	2,680	.2
Auberry coarse sandy loam, 3 to 9 percent slopes, eroded	250	(1)
Auberry coarse sandy loam, 9 to 15 percent slopes	6,553	.6
Auberry coarse sandy loam, 9 to 15 percent slopes, eroded	596	.1
Auberry coarse sandy loam, 15 to 30 percent slopes	8,001	.7
Auberry coarse sandy loam, 15 to 30 percent slopes, eroded	[illegible]	(1)
Auberry coarse sandy loam, 30 to 45 percent slopes	6,280	.5
Auberry coarse sandy loam, 45 to 70 percent slopes	2,704	.2
Auberry very rocky coarse sandy loam, 3 to 30 percent slopes	13,013	1.2
Auberry very rocky coarse sandy loam, 30 to 45 percent slopes	4,47[illegible]	.4
Auberry very rocky coarse sandy loam, [illegible] percent slopes	4,21[illegible]	.4
Auberry very rocky coarse sandy loam, [illegible] 70 percent slopes	1,847	.2
Auberry-Sierra coarse sandy loams, 15 to 30 percent slopes	1,123	.1
Auberry-Sierra coarse sandy loams, 30 to 45 percent slopes	1,324	.1
Auberry-Sierra coarse sandy loams, 45 to 70 percent slopes	463	(1)
Auberry-Sierra very rocky coarse sandy loams, [illegible] percent slopes	445	(1)
Auberry-[illegible]-Rock land complex, [illegible] to 70 percent slopes	1,777	.2
[illegible]	[illegible]	.1
[illegible] percent slopes	[illegible]	.2
[illegible] percent slopes	[illegible]	[illegible]
[illegible] percent slopes	[illegible]	[illegible]
[illegible] percent slopes	[illegible]	.2
[illegible] percent slopes	[illegible]52	.1
B[illegible] very rocky [illegible] to 30 percent slopes	855	.1
B[illegible] very rocky loam, [illegible] to 70 percent slopes	2,392	.2

TABLE 1.—*Approximate acreage and proportionate extent of the soils of the Eastern Fresno Area*—Continued

Soil	Area	Extent
	Acres	*Percent*
Blasingame extremely rocky loam, shallow, [illegible] percent slopes	2,[illegible]20	.2
Blasingame [illegible] loam, shallow, [illegible] to [illegible] percent slopes	[illegible]	[illegible]
Blasingame clay loam, shallow, 30 to 45 percent slopes	381	([1])
Blasingame [illegible] rocky clay loam, [illegible] to 45 percent slopes	[illegible]	[illegible]
Borden loam	[illegible]	[illegible]
Borden loam, saline-alkali	391	([1])
[illegible] loam, moderately deep	[illegible]	([1])
[illegible] loam, moderately deep, saline-alkali	[illegible]	[illegible]
[illegible] sandy coarse [illegible]	[illegible]	.1
[illegible] saline-alkali	[illegible]	[illegible]
[illegible] sandy loam	[illegible]	[illegible]
[illegible]	[illegible]	.1
[illegible] loam [illegible] saline-alkali	[illegible]	[illegible]
Calhi loamy sand, 0 to 3 percent slopes	17,503	1.5
Calhi loamy sand, 3 to 9 percent slopes	2,846	.2
[illegible] loam, moderately deep [illegible] percent slopes	[illegible]	[illegible]
[illegible] 0 to 3 percent slopes	[illegible]	[illegible]
[illegible] clay, [illegible] to [illegible] percent slopes	[illegible]	.1
[illegible] cobbly clay [illegible]	[illegible]	[illegible]
[illegible] cobbly clay, 9 to 30 percent slopes	[illegible]	[illegible]
[illegible] sandy loam	[illegible]	[illegible]
[illegible] sandy loam, saline-alkali	[illegible]	[illegible]
[illegible] fine sandy loam	2,365	.2
[illegible] fine sandy loam [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible] loam	[illegible]	[illegible]
[illegible] saline-alkali	[illegible]	[illegible]
Cibolar sandy loam, 0 to 3 percent slopes	[illegible]	[illegible]
Cibolar sandy loam, 3 to 9 percent slopes	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible] very rocky clay, 9 to 30 percent slopes	642	.1
[illegible] very rocky clay, 30 to 45 percent slopes	1,[illegible]34	[illegible]
[illegible] very rocky clay, 45 to 70 percent slopes	[illegible]	[illegible]
[illegible]	1,[illegible]	.1
[illegible] rocky clay, [illegible] percent slopes	2,427	.2
[illegible] sandy [illegible] percent slopes	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	.2
[illegible]	[illegible]	[illegible]
[illegible] sandy [illegible]	[illegible]	[illegible]
Colluvial land	419	([1])
[illegible] percent slopes	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Cometa sandy loam, 15 to 30 percent slopes	[illegible]	[illegible]
Cometa loam, 2 to 9 percent slopes	2,[illegible]31	.2
Cometa-San Joaquin sandy loams, 3 to [illegible] percent slopes	[illegible]	.1
[illegible] sand, 0 to [illegible] percent slopes	2,[illegible]52	.2
[illegible] sand [illegible] percent slopes	2,[illegible]61	.2
[illegible] loamy sand [illegible] percent slopes	38,8[illegible]4	3.5
[illegible] loamy sand [illegible] percent slopes	[illegible]	.7
[illegible] loam, moderately deep, [illegible] to [illegible] percent slopes	3,[illegible]67	.3
[illegible] sand	4,[illegible]	.4
[illegible]	2,494	.2
[illegible] stony loam, 30 to 45 percent slopes	274	([1])
[illegible] stony loam, 45 to 70 percent slopes	721	.1
[illegible]	4,[illegible]	.4
[illegible]	1,[illegible]	.1
[illegible] sandy loam	8,[illegible]	.8
[illegible]	[illegible]	.1
[illegible] sandy loam	12,[illegible]	1.2
[illegible] shallow	[illegible]	[illegible]
Exeter loam	5,505	.5
Fallbrook sandy loam, 3 to 9 percent slopes	3,8[illegible]9	.3
Fallbrook [illegible] to [illegible] percent slopes	[illegible]222	[illegible]
Fallbrook [illegible] percent slopes	1,206	[illegible]
Fallbrook [illegible] 45 percent slopes	574	[illegible]
[illegible] sandy loam, shallow [illegible]	920	.1
[illegible] sandy loam, shallow, [illegible] to 30 percent slopes	2,175	.2
Fallbrook very rocky [illegible] to [illegible]	[illegible]	.7
Fallbrook [illegible] rocky [illegible] to [illegible]	1,[illegible]24	.1
[illegible] shallow, 3 to 30 percent slopes	2,100	.2
[illegible] shallow, 30 to 70 percent slopes	1,814	.2
[illegible]	[illegible]36	.1
[illegible]	[illegible]	[illegible]
[illegible] 5 to 70 percent slopes	[illegible]	.5
[illegible]	[illegible]	.1
Fancher-Blasingame complex, 45 to 70 percent slopes	[illegible]	.2
[illegible]	[illegible]	[illegible]
[illegible] loam	1,[illegible]	.1
[illegible]	[illegible]	([1])
Foster loam, moderately deep	847	([1])
Foster loam, moderately deep, saline-alkali	1,[illegible]	.1
[illegible]	[illegible]	.9
[illegible] shallow	[illegible]	.2
[illegible]	[illegible]	1.3
[illegible] shallow	[illegible]	.5
[illegible]	[illegible]	.1
[illegible]	[illegible]	.1
[illegible] percent	[illegible]	.1
Friant fine sandy loam, 30 to 45 percent slopes	1,1[illegible]	.1
[illegible]	[illegible]	[illegible]
[illegible] saline-alkali	[illegible]	.1
Grangeville sandy loam, sandy substratum	[illegible]	.1
Grangeville fine sandy loam	16,674	1.5
[illegible]	[illegible]	[illegible]

TABLE 1. *Approximate acreage and proportionate extent of the soils of the Eastern Fresno Area*—Continued

Soil	Area	Extent
	Acres	*Percent*
Grangeville fine sandy loam, water table	552	([1])
Grangeville fine sandy loam, water table, saline-alkali	739	.1
Grangeville fine sandy loam, gravelly substratum	1,831	.2
Grangeville fine sandy loam, sandy substratum	1,952	2
Grangeville fine sandy loam, hard substratum	1,242	1
Grangeville fine sandy loam, hard substratum, saline-alkali	1,256	1
Grangeville soils, channeled	2,578	.2
Granitic rock land	4,294	.4
Greenfield coarse sandy loam, 0 to 3 percent slopes	1,314	1
Greenfield sandy loam, 0 to 3 percent slopes	8,740	.8
Greenfield sandy loam, 3 to 9 percent slopes	547	([1])
Greenfield sandy loam, moderately deep, 0 to 3 percent slopes	9,586	.9
Hanford coarse sandy loam	10,722	1.0
Hanford coarse sandy loam, hard substratum	328	([1])
Hanford sandy loam	28,095	2.6
Hanford sandy loam, benches	1,399	1
Hanford sandy loam, gravelly substratum	2,266	.2
Hanford sandy loam, sandy substratum	384	([1])
Hanford sandy loam, silty substratum	26,011	2.4
Hanford sandy loam, clay loam substratum	277	([1])
Hanford sandy loam, hard substratum	2,380	.2
Hanford gravelly sandy loam	974	1
Hanford fine sandy loam	29,839	2.7
Hanford fine sandy loam, gravelly substratum	1,936	2
Hanford fine sandy loam, silty substratum	7,440	7
Hanford fine sandy loam, clay loam substratum	292	([1])
Hanford fine sandy loam, hard substratum	1,582	.1
Hesperia coarse sandy loam	1,567	1
Hesperia coarse sandy loam, saline-alkali	600	([1])
Hesperia sandy loam	20,936	1.9
Hesperia sandy loam, saline-alkali	3,057	.3
Hesperia sandy loam, moderately deep	26,548	2.4
Hesperia sandy loam, moderately deep, saline-alkali	6,398	.6
Hesperia sandy loam, shallow	949	1
Hesperia sandy loam, shallow, saline-alkali	1,250	1
Hesperia fine sandy loam	20,390	1.8
Hesperia fine sandy loam, saline-alkali	429	([1])
Hesperia fine sandy loam, moderately deep	21,318	1.9
Hesperia fine sandy loam, moderately deep, saline-alkali	12,358	1.1
Hideaway extremely stony loam, 3 to 15 percent slopes	1,241	1
Hildreth clay	3,212	.3
Holland coarse sandy loam, 15 to 45 percent slopes	327	([1])
Honcut fine sandy loam, 0 to 2 percent loam	713	1
Honcut fine sandy loam, 2 to 9 percent slopes	318	([1])
Honcut fine sandy loam, gravelly substratum, 0 to 3 percent slopes	461	([1])
Honcut fine sandy loam, hard substratum, 0 to 3 percent slopes	230	([1])
Keefers loam, 3 to 15 percent slopes	215	([1])
Keefers cobbly loam, 3 to 30 percent slopes	1,154	.1
Keyes cobbly clay loam, 3 to 15 percent slopes	788	.1
Los Robles sandy loam, 2 to 9 percent slopes	519	([1])
Los Robles sandy loam, gravelly substratum, 2 to 9 percent slopes	205	([1])
Los Robles loam, 0 to 3 percent slopes	1,797	.2
Los Robles loam, 3 to 9 percent slopes	971	.1
Los Robles loam, hard substratum, 2 to 9 percent slopes	206	([1])
Los Robles clay loam, 0 to 3 percent slopes	595	.1
Madera sandy loam	978	.1
Madera loam	2,492	.2
Madera loam, saline-alkali	290	([1])
Madera clay loam	253	([1])
Merced clay loam	3,812	.3
Merced clay loam, slightly saline	2,486	.2
Merced clay	2,044	.2
Merced clay, slightly saline	13,664	1.2
Merced clay, moderately saline	760	.1
Merced clay, saline-alkali	495	([1])
Millerton fine sandy loam, 9 to 30 percent slopes	3,713	.3
Millerton fine sandy loam, 30 to 45 percent slopes	2,378	.2
Millerton fine sandy loam, 45 to 70 percent slopes	1,610	.1
Millerton fine sandy loam, 45 to 70 percent slopes, eroded	279	([1])
Millerton rocky fine sandy loam, 3 to 30 percent slopes	264	([1])
Millerton very rocky fine sandy loam, 30 to 45 percent slopes	678	1
Millerton very rocky fine sandy loam, 45 to 70 percent slopes	1,497	.1
Montpellier coarse sandy loam, 9 to 15 percent slopes	286	([1])
Montpellier coarse sandy loam, 15 to 30 percent slopes	446	([1])
Mt. Olive clay, 3 to 9 percent slopes	419	([1])
Mt. Olive clay, 9 to 15 percent slopes	648	([1])
Nord loam	336	([1])
Nord loam, saline-alkali	492	([1])
Pachappa loam	1,364	1
Pachappa loam, saline-alkali	1,911	.2
Pachappa loam, moderately deep	2,840	.2
Pachappa loam, moderately deep, saline-alkali	3,085	.3
Piper sandy loam, 0 to 9 percent slopes	397	([1])
Piper fine sandy loam, 0 to 9 percent slopes	134	([1])
Piper-Rossi complex, 0 to 9 percent slopes	402	([1])
Pits	727	1
Playas	1,942	.2
Pollasky sandy loam, 2 to 9 percent slopes	683	.1
Pollasky sandy loam, 9 to 15 percent slopes	289	([1])
Pollasky sandy loam, 15 to 30 percent slopes	259	([1])
Pollasky fine sandy loam, 2 to 9 percent slopes	350	([1])
Pollasky fine sandy loam, 9 to 15 percent slopes	192	([1])

TABLE 1.—*Approximate acreage and proportionate extent of the soils of the Eastern Fresno Area*—Continued

Soil	Area	Extent
	Acres	*Percent*
Pollasky-Montpellier complex, 9 to 15 percent slopes	915	.1
Pollasky-Montpellier complex, 15 to 30 percent slopes	1,878	.2
Pollasky-Rocklin sandy loams, 3 to 15 percent slopes	374	([1])
Pond sandy loam	740	.1
Pond sandy loam, moderately deep	876	.1
Pond fine sandy loam	3,278	.3
Pond fine sandy loam, moderately deep	1,676	.1
Pond loam	307	([1])
Pond loam, moderately deep	2,314	.2
Porterville clay, 0 to 3 percent slopes	6,915	.6
Porterville clay, 3 to 15 percent slopes	2,265	.2
Porterville cobbly clay, 3 to 15 percent slopes	1,365	.1
Porterville very cobbly clay, 9 to 30 percent slopes	1,031	.1
Positas gravelly loam, 3 to 9 percent slopes	298	([1])
Positas gravelly loam, 9 to 30 percent slopes	396	([1])
Positas gravelly loam, 30 to 45 percent slopes	671	.1
Ramona sandy loam	11,902	1.1
Ramona sandy loam, hard substratum	10,930	1.0
Ramona loam	7,009	.6
Ramona loam, gravelly substratum	640	.1
Ramona loam, hard substratum	3,976	.3
Redding gravelly loam, 3 to 15 percent slopes	429	([1])
Redding gravelly loam, shallow, 0 to 8 percent slopes	256	([1])
Riverwash	2,077	.2
Rocklin sandy loam, 0 to 9 percent slopes	287	([1])
Rocklin sandy loam, pumiceous variant, 3 to 30 percent slopes	238	([1])
Rosa fine sandy loam	5,715	.5
Rosa clay loam	732	.1
Sandy alluvial land	157	([1])
Sandy alluvial land, leveled	290	([1])
San Joaquin sandy loam, 0 to 3 percent slopes	14,102	1.3
San Joaquin sandy loam, shallow, 0 to 3 percent slopes	15,169	1.4
San Joaquin sandy loam, shallow, 3 to 9 percent slopes	500	([1])
San Joaquin loam, 0 to 3 percent slopes	19,913	1.8
San Joaquin loam, gravelly substratum, 0 to 3 percent slopes	568	.1
San Joaquin loam, shallow, 0 to 3 percent slopes	11,871	1.1
San Joaquin loam, shallow, 3 to 9 percent slopes	1,542	.1
San Joaquin-Alamo complex, 3 to 9 percent slopes	289	([1])
Sesame sandy loam, 3 to 9 percent slopes	1,313	.1
Sesame sandy loam, 9 to 15 percent slopes	1,069	.1
Sesame sandy loam, 15 to 30 percent slopes	305	([1])
Sesame loam, 3 to 9 percent slopes	1,614	.1
Sesame loam, 9 to 15 percent slopes	191	([1])
Shaver coarse sandy loam, 15 to 45 percent slopes	219	([1])
Sierra sandy loam, 9 to 15 percent slopes	717	.1
Sierra sandy loam, 15 to 30 percent slopes	777	.1
Sierra sandy loam, 30 to 45 percent slopes	2,517	.2
Sierra sandy loam, 45 to 70 percent slopes	972	.1
Sierra very rocky sandy loam, 3 to 30 percent slopes	1,332	.1
Sierra very rocky sandy loam, 30 to 45 percent slopes	2,048	.2
Sierra very rocky sandy loam, 45 to 70 percent slopes	2,481	.2
Sierra-Tollhouse-Rock land complex, 45 to 70 percent slopes	293	([1])
Swamp	[illegible]	.1
Temple loam	6,368	.6
Temple loam, saline	587	.1
Temple loam, saline-alkali	2,177	.2
Temple clay loam	6,532	.6
Temple clay loam, saline	910	.1
Temple clay loam, saline-alkali	1,890	.2
Temple clay	309	([1])
Terrace escarpments	702	.1
Tivy loam, 3 to 9 percent slopes	438	([1])
Tivy loam, 9 to 30 percent slopes	3,360	.3
Tivy loam, 30 to 45 percent slopes	1,142	.1
Tivy loam, 45 to 70 percent slopes	561	([1])
Tivy very rocky loam, 9 to 30 percent slopes	1,247	.1
Tivy very rocky loam, 30 to 70 percent slopes	1,579	.1
Tollhouse extremely rocky coarse sandy loam, 30 to 70 percent slopes	1,693	.1
Toomes extremely cobbly loam, 30 to 70 percent slopes	853	.1
Trabuco loam, 9 to 15 percent slopes	145	([1])
Trabuco loam, 15 to 30 percent slopes	242	([1])
Trabuco loam, 30 to 45 percent slopes	1,3[illegible]1	.1
Trabuco loam, 45 to 70 percent slopes	2,204	.2
Trabuco very rocky loam, 30 to 45 percent slopes	386	([1])
Trabuco very rocky loam, 45 to 70 percent slopes	3,674	.3
Traver sandy loam	3,693	.3
Traver sandy loam, moderately deep	8,368	.7
Traver fine sandy loam	8,568	.8
Traver fine sandy loam, moderately deep	10,901	1.0
Tretten fine sandy loam, 3 to 15 percent slopes	224	([1])
Tretten fine sandy loam, 15 to 30 percent slopes	389	([1])
Tretten fine sandy loam, 30 to 45 percent slopes	798	.1
Tretten fine sandy loam, 45 to 70 percent slopes	668	.1
Tretten very rocky fine sandy loam, 45 to 70 percent slopes	1,823	.2
Trimmer loam, 3 to 15 percent slopes	555	.1
Trimmer loam, 15 to 30 percent slopes	1,466	.1
Trimmer loam, 30 to 45 percent slopes	4,079	.4
Trimmer loam, 45 to 70 percent slopes	6,015	.5
Trimmer very rocky loam, 30 to 45 percent slopes	825	.1
Trimmer very rocky loam, 45 to 70 percent slopes	2,429	.2
Trimmer-Tretten complex, 15 to 45 percent slopes	346	([1])
Trimmer-Tretten complex, 45 to 70 percent slopes	2,468	.2
Tujunga sand, 0 to 3 percent slopes	662	.1
Tujunga loamy sand, 0 to 3 percent slopes	14,672	1.3
Tujunga loamy sand, 3 to 9 percent slopes	606	.1

TABLE 1.—*Approximate acreage and proportionate extent of the soils of the Eastern Fresno Area*—Continued

Soil	Area	Extent
	Acres	*Percent*
Tujunga loamy sand, gravelly substratum, 0 to 3 percent slopes	380	(1)
Tujunga cobbly loamy sand, 0 to 3 percent slopes	708	.1
Tujunga loamy sand, channeled, 0 to 3 percent slopes	3,603	.3
Visalia sandy loam, 0 to 3 percent slopes	2,[illegible]32	.2
Visalia sandy loam, 3 to 9 percent slopes	976	.1
Visalia sandy loam, [illegible] substratum, 0 to 3 percent slopes	325	(1)
Visalia loam, 0 to 3 percent slopes	207	(1)
Vista coarse sandy loam, 3 to 9 percent slopes	2,651	.2
Vista coarse sandy loam, 9 to 15 percent slopes	6,369	.6
Vista coarse sandy loam, 15 to 30 percent slopes	6,693	.6
Vista coarse sandy loam, 30 to 45 percent slopes	3,012	.3
Vista coarse sandy loam, 45 to 70 percent slopes	1,376	.1
Vista coarse sandy loam, shallow, 3 to 9 percent slopes	1,164	.1
Vista coarse sandy loam, shallow, 9 to 30 percent slopes	7,335	.7
Vista coarse sandy loam, shallow, 30 to 45 percent slopes	688	.1
Vista very rocky coarse sandy loam, 3 to 30 percent slopes	5,8[illegible]9	.5
Vista very rocky coarse sandy loam, 30 to 45 percent slopes	4,484	.4
Vista very rocky coarse sandy loam, 45 to 70 percent slopes	1,278	.1
Vista very rocky coarse sandy loam, shallow, 3 to 30 percent slopes	[illegible]	.1
Vista very rocky coarse sandy loam, shallow, 30 to 70 percent slopes	7,454	.7
Vista extremely rocky coarse sandy loam, 3 to 30 percent slopes	521	(1)
Vista-Fallbrook coarse sandy loams, 9 to 30 percent slopes	454	(1)
Vista-Fallbrook very rocky coarse sandy loams, 3 to 30 percent slopes	1,686	.1
Vista-Fallbrook very rocky coarse sandy loams, 30 to 45 percent slopes	1,090	.1
Vista-Fallbrook extremely rocky coarse sandy loams, 30 to 70 percent slopes	997	.1
Waukena fine sandy loam	790	.1
W[illegible] loam	1,795	.2
W[illegible] loam, 3 to 9 percent slopes	[illegible]	(1)
W[illegible] loam, 9 to 30 percent slopes	1,239	.1
W[illegible] loam, 30 to 45 percent slopes	579	.1
W[illegible] loam, 45 to 70 percent slopes	215	(1)
W[illegible] very rocky loam, 3 to 30 percent slopes	210	(1)
Wunjey fine sandy loam	627	.1
W[illegible] sandy loam	1,175	.1
Yokohl loam, 0 to 3 percent slopes	586	.1
Yokohl loam, 3 to 9 percent slopes	591	.1
Yokohl loam, moderately deep, 0 to 3 percent slopes	1,180	.1
Yokohl loam, moderately deep, 3 to 9 percent slopes	407	(1)
Yokohl gravelly loam, 3 to 9 percent slopes	683	.1
Yokohl clay loam, moderately deep, 0 to 3 percent slopes	286	(1)
Water	5,[illegible]96	.5
Intermittent water	3,720	.3
Made land or spoil banks	1,762	.1
Total	1,109,156	100.0

[1] Less than 0.05 percent.

Academy Series

The Academy series consists of well-drained soils that have mainly a dense, moderately fine textured subsoil. These soils are nearly level to gently rolling. They are moderately deep over moderately coarse textured, compact sediments that consist of old alluvial terrace material. This material was deposited by many small streams that drain areas in the lower foothills made up of metamorphic, basic, and intermediate igneous rocks.

The Academy soils occur mainly adjacent to the foothills east of Clovis at elevations of from 400 to 600 feet. According to elevation, average annual rainfall ranges from 13 to 16 inches. The average annual temperature is 62° F.; the average growing season is 275 days. The natural vegetation is a cover of annual grasses and forbs.

In a typical profile, the surface layer is slightly acid to medium acid, dark-brown loam about 6 inches thick. The upper few inches of the subsoil is dark-brown heavy loam, but most of the subsoil is dense, reddish-brown to brown sandy clay loam or clay loam that is slightly acid or neutral. The subsoil grades abruptly to the compact parent sediments at a depth of about 30 inches.

The Academy soils are used mainly for range and pasture and for growing grain, particularly barley. However, some areas of these soils are being used for orange groves because of the relatively low frost hazard. Other areas of these soils are being used for residential development. A large supply of ground water is not available for all areas of these soils.

Representative profile on an easterly slope of 5 percent, in an area of recently abandoned, dryfarmed grainland under a sparse cover of annual grasses and forbs and some volunteer barley, at an elevation of about 425 feet (7½ miles E. of Clovis in the SE¼NW¼NW¼ sec. 3, T. 13 S., R. 22 E.):

Ap—0 to 6 inches, dark-brown (10YR 4/3) loam, dark brown (7.5YR 3/2) when moist; massive; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant fine and very fine roots; common fine and very fine tubular pores; medium acid (pH 5.7); clear, smooth lower boundary.

B1t—6 to 12 inches, dark-brown (7.5YR 3/3) heavy loam, dark brown (7.5YR 3/2) when moist; weak, coarse, angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; plentiful fine and very fine roots; many very fine and common fine tubular pores; common thin clay films on ped faces and in some pores; medium acid (pH 5.7); clear, wavy lower boundary.

B21t—12 to 20 inches, reddish-brown (5YR 4/3) heavy

sandy clay loam, dark reddish brown (5YR 3/4) when moist; weak, coarse, prismatic structure breaking to moderate, coarse, angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; plentiful very fine roots; common very fine tubular pores; moderately thick continuous clay films on ped faces and in pores; slightly acid (pH 6.1); clear, wavy lower boundary.

B22t—20 to 30 inches, brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) when moist; few, medium, distinct, reddish-brown mottles; weak, coarse, angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; few very fine roots; many very fine tubular pores; many thin clay films on ped faces and in pores; neutral (pH 6.7); abrupt, irregular lower boundary.

C—30 inches +, light yellowish-brown (10YR 6/4) softly to moderately consolidated mixed sandy sediment; many few, thick, dark brown (7.5YR 4/4) when moist; massive; occasionally fractured; very hard to extremely hard when dry, firm to friable when moist; dark-brown to reddish-brown clay films on some fracture faces in upper part of layer.

The A horizon ranges from brown (10YR 5/3) to dark brown with a reddish tint (7.5YR 4/4) but is ordinarily dark brown (10YR 5/3 or 4/3). When this layer is moist, it is generally a somewhat darker brown (10YR 3/3, 7.5YR 3/2). This horizon is typically massive, or cloddy when tilled, and the dry consistence is hard or very hard. The reaction commonly ranges from slightly acid to medium acid, but in a few places it is neutral.

The B horizon is ordinarily reddish brown (5YR 4/3 or 4/4) but it ranges to brown or dark brown or strong brown (7.5YR 5/4 or 4/4). When moist, it is generally dark reddish brown (5YR 3/2 or 3/4) but ranges to dark brown (7.5YR 4/4) or yellowish red (5YR 4/8). The texture of the B2t horizon ranges from sandy clay loam to clay loam. The structure, not including that of transitional horizons, ranges from moderate to strong angular blocky, tending weakly toward a prismatic structure in the upper part of the B2t horizon. The reaction is ordinarily neutral but ranges from slightly acid to mildly alkaline.

The boundary between the B horizon and the C horizon is generally abrupt and is either wavy or irregular. The C horizon is generally massive but is commonly broken by some vertical and horizontal cracks. It consists of poorly sorted, weakly to moderately consolidated [illegible] sediments from mixed rocks. When this horizon is dry, it is very hard to extremely hard. When wet, it tends to slake somewhat, but generally remains very firm. In some places there is clay bonding, weak sand grain to sand grain cementation [illegible].

The thickness of the solum ranges from about 18 to 52 inches, but in most areas it ranges between 24 and 36 inches. The thickness of the A horizon ranges from [illegible] to 16 inches. The thickness of the B1 horizon is commonly 12 to 24 inches, but it ranges from 4 to 40 inches in places.

Academy loam, 3 to 9 percent slopes (AaB).—This soil is undulating to gently rolling. It is generally well drained, but its permeability is slow to very slow. Runoff is medium from the slopes, but it tends to collect in a branching system of connected swales from which water drains slowly. During the rainy season a temporary perched zone of saturation often develops above the dense subsoil in the more gently sloping areas. The total capacity of the soil to store moisture is high, but its capacity to hold moisture available to plants is low to medium. The natural fertility is fair; the hazard of erosion is moderate.

This soil is mainly in the vicinity of Academy and near Round Mountain, although there are some minor areas in small valleys east of Round Mountain, in Tivy and Clark Valleys east of the Kings River, and in the vicinity of Navelencia.

Included with this soil in mapping were small areas of Yokohl soils on the crests of knolls or on low ridges; minor areas of Hildreth and Alamo clays in some depressions and meandering swales; and small areas of Academy soils that have a surface layer of clay loam.

This soil has been used mainly for dryfarmed barley, rotated in alternate years with fallow. The soil is well suited to this use because of its medium moisture-holding capacity, but barley may be drowned out in some swales. The stubble is grazed in many places by cattle or sheep. This soil is now being used more for citrus groves, permanent pasture, and community development than for dryfarming, but it is also used for range. Forage plants respond very well to nitrogen. Where enough water is available, irrigated crops are grown. In some areas this soil has been ripped, reshaped, and leveled to provide a deeper root zone for citrus trees and to improve efficiency of irrigation. Capability unit IIIe–8 (17); range site 8; natural land type E1; Storie index rating 39.

Academy loam, 0 to 3 percent slopes (AaA).—This soil is similar to Academy loam, 3 to 9 percent slopes, but differs in its surface relief. It is mainly gently undulating and is marked by branches of connected drainage swales. Some areas of this soil have been leveled. The soil is generally well drained. Runoff is slow, and the hazard of erosion is slight. This soil is mainly in the vicinity of Round Mountain and Granite Hill.

Included with this soil in mapping, near the mouth of Holland Creek, was a small area of a soil that has a surface layer of gravelly loam. Also included in several places were areas of Yokohl soils on the crests of low knolls and areas of Alamo clay in some depressions.

This soil is used mainly for dryfarmed barley and for grazing. Where leveled, it is used for irrigated pasture, to which it is well suited, or for growing cotton. Leveling operations that involve ripping tend to deepen the effective root zone of the soil. However, a restrictive layer remains beneath the surface in the form of parts of the dense subsoil or of partly shattered, compact parent sediments. Continued care must be given to the amount of irrigation water applied to field crops so as to avoid developing a saturated zone in the soil that is damaging to roots. Nitrogen and phosphorus are generally needed. Capability unit IIIs–8 (17); range site 8; natural land type E1; Storie index rating 42.

Ahwahnee Series

The Ahwahnee series consists of well drained to somewhat excessively drained, moderately coarse textured soils that have a slightly compact but permeable subsoil. These soils are undulating to very steep. They are moderately deep or deep to weathered quartz diorite, which crops out in places.

These soils occur mainly north of the Kings River,

for the most part at elevations of 1,000 to 2,500 feet. Some areas on north-facing slopes or in deep canyons are at elevations of less than 1,000 feet; and south of the Kings River, near Miramonte, some areas are at elevations ranging up to 3,000 feet. According to elevation, average annual rainfall ranges from 18 to 30 inches; average annual temperature from 60° to 57° F., and average growing season from 200 to 225 days.

The natural vegetation is a combination of woody plants and grass (fig. 3). The trees are mainly blue oak and interior live oak, with some California buckeye and Digger pine; the grass cover is a mixture of annual grasses and forbs; and the brush is mainly buckbrush, chaparral, white-thorn, Mariposa manzanita, and poison-oak. The growth of trees and grass is parklike at the lower elevations. The brush cover increases with elevation, though this is partly offset by local range improvement.

In a typical profile, the surface layer is slightly acid, grayish-brown coarse sandy loam about 10 inches thick. The subsoil is brown to pale-brown coarse sandy loam of subangular blocky structure. This layer has a slightly higher clay content and is more acid than the surface layer. Weathered quartz diorite is at a depth of about 36 inches.

The Ahwahnee soils are used mainly for annual range and are well suited to this use. Forage yield is better in the upper foothills than in other parts because more precipitation falls there. The soils are extensive parts of local watersheds and are important in wildlife management. Small acreages of grain are grown for hay in accessible areas having gentle slopes.

Figure 3.—Typical landscape and vegetation of Ahwahnee soils.

Some turkey growers select these and other moderately coarse textured, well-drained soils for farm sites. Many areas of Ahwahnee soils are now being diverted from range to country residential use. Water for domestic use and for livestock is obtained from springs, many intermittent streams, and a few perennial streams. Small dams on the intermittent streams help to lengthen the season during which surface water is available. Some water is obtained from shallow wells in the weathered country rock, or in alluvium along small streams.

Representative profile on a northerly slope of about 6 percent, in range pasture supporting annual grasses and oak, at an elevation of about 1,250 feet (4½ miles, airline, NNW of Auberry, near center NW¼ NE¼ sec. 19, T. 9 S., R. 23 E.):

O1—½ inch to 0, loose litter consisting of dry annual grass and parts of forbs.

A1—0 to 10 inches, grayish brown (10YR 5/2) coarse sandy loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure tending toward weak, medium, subangular blocky; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; abundant fine roots and few medium and coarse roots; many fine tubular and very fine interstitial pores; many fine flakes of mica; slightly acid (pH 6.3); clear, smooth lower boundary.

B2t—10 to 36 inches, brown to pale-brown (10YR 5/3 to 6/3) coarse sandy loam, dark yellowish brown (10YR 4/4 to 3/4) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; slightly sticky and nonplastic when wet; few fine roots and very few coarse roots; few fine tubular and many fine interstitial pores; thin, slightly darker clay films in tubular pores and as bridgings and grain coatings; many fine flakes of mica; slightly acid (pH 6.1); abrupt, irregular lower boundary.

C—36 inches +, varicolored, weathered quartz diorite consisting of glassy, colorless grains of quartz, whitish to yellowish brown grains of feldspar, and scattered black to dark yellowish-brown fragments of biotite and other dark-colored minerals; fabric of the original granitic rock still clearly visible when material is in place, and detached fragments crush readily to a loose, loamy coarse sand; many interstitial pores in the undisturbed mass; occasional coarse roots follow former joint planes or penetrate weathered mass; grades to unweathered rock at variable depths, commonly more than 10 feet from surface.

The A horizon ranges to brown (10YR 5/3) but ordinarily is grayish brown or dark grayish brown (10YR 5/2 or 4/2). When this layer is moist, it ranges from dark brown to very dark grayish brown (10YR 3/3 to 3/2). The structure is commonly granular, but in places it is crumb, and in areas much trampled by grazing animals it appears massive. The grade of structure ranges from weak to moderate. The dry consistence is normally slightly hard, but it ranges to soft where crumb structure exists. The reaction ranges from slightly acid to medium acid.

The B2t horizon ranges from brown to pale brown or light brownish gray (10YR 5/3, 6/3, or 6/2) when dry. When moist, it ranges from dark brown to dark yellowish brown (10YR 3/3, 3/4, or 4/4), and occasionally to very dark grayish brown (10YR 3/2). There is no difference in textural class between the A horizon and the B2t horizon, but the slight increase in clay content in the B2t is reflected in the consistence, which is hard when dry and ordinarily slightly sticky when wet. The increase in clay content is also evidenced by thin clay films that coat some tubular pores, act as a bridging material between sand grains, or appear as few or common coatings on some ped faces. The B2t horizon is massive or has weak subangular blocky structure. The reaction of the B2t horizon ranges from slightly acid to medium but is normally somewhat more acid than that of the A horizon. In places there is no difference in reaction between the A and the B2t horizons.

The C horizon is quartz diorite that has been deeply weathered and that randomly includes stone- or boulder-size remnants of the unweathered parent rock. The upper boundary of the C horizon is abrupt; the shape of this boundary, however, ranges from smooth to wavy or irregular.

The depth of soil over weathered parent rock ranges mainly from 18 to 42 inches, but in places the depth to rock is about 70 inches. The thickness of the A horizon ranges from 8 to 14 inches, and that of the B2t horizon, from 10 to 34 inches.

Ahwahnee coarse sandy loam, 9 to 15 percent slopes (AcC).—A rolling surface and occasional rock outcrops are characteristic of this soil. Its profile is similar to the typical profile of the series. This soil is well drained. Its permeability is moderately rapid, and runoff is medium. The hazard of erosion is moderate. The available moisture-holding capacity ranges from low to moderate, depending on variation in depth.

This soil is mainly in the northern part of the upper foothill section in the vicinities of Auberry and Tollhouse. A small proportion is near Dunlap and Miramonte, south of the Kings River, and many small isolated areas are in protected sites scattered from Millerton Lake to Pine Flat Reservoir and along parts of the Sand Creek drainage system southeast of Squaw Valley.

Included with this soil in mapping were minor areas more than 48 inches deep to bedrock, narrow strips of Visalia and Chualar soils bordering small drainageways; and particularly near Cold Spring Rancheria and Watts Valley, a complex intermingling of Auberry soils. Also included were soils lacking a developed subsoil, or B horizon, but otherwise similar to this soil.

This soil is used mainly for range pasture. It is well suited to more intensive management for pasture. Where enough water is available, it is fairly well suited as pasture irrigated by a sprinkler system. If moisture is adequate, forage crops respond well to nitrogen and phosphorus. Growth of legumes is improved by application of sulfur in the form of gypsum or in superphosphate. Capability unit IIIe-8 (18); range site 2; natural land type E3, Storie index rating 46.

Ahwahnee coarse sandy loam, 3 to 9 percent slopes (AcB).—This soil is similar to Ahwahnee coarse sandy loam, 9 to 15 percent slopes, and has the profile described as typical for the series. Runoff is slow because the soil is permeable and undulating to gently rolling. The hazard of erosion is slight to moderate.

Small areas of this soil are widely distributed in the upper foothill region. It provides good dry pasture, and where water is available, can be used for irrigated pasture. The soil is also used for wild hay, or dry-farmed grain is grown on it and cut for hay. Capability unit IIIe-8 (18); range site 2; natural land type E3, Storie index rating 48.

Ahwahnee coarse sandy loam, 15 to 30 percent slopes (AcD).—This soil is hilly to moderately steep but otherwise resembles Ahwahnee coarse sandy loam,

9 to 15 percent slopes. Numerous small areas are in the upper foothill area reaching from the San Joaquin River canyon to the vicinity of Squaw Valley and Dunlap. Runoff is medium to rapid, and the hazard of erosion is moderate to high.

Included with this soil in mapping were small areas of similar soils less than 24 inches or greater than 48 inches deep over bedrock. A few small areas near Dunlap and Miramonte are moderately eroded. Included also are two small areas near Auberry Valley that are similar to this soil in all respects except stoniness. Blocks of stone have tumbled onto these areas from basaltic cliffs above. Near Watts Valley, Squaw Valley, and Dunlap and Miramonte, Auberry soils are intricately intermingled with this soil.

This Ahwahnee soil is used for range. It is practical to convert brushy areas to improve forage. Clearing or killing the brush is ordinarily followed by reseeding and fertilization. Capability unit VIe-1 (17, 18), range site 2, natural land type E3. Storie index rating 39

Ahwahnee coarse sandy loam, 30 to 45 percent slopes (AcE).—This soil is on hills and ridges southwest of Auberry, in Watts Valley near Pine Flat Dam, and in the vicinities of Dunlap and Miramonte. Drainage is somewhat excessive. Runoff is rapid, and the erosion hazard is high. In other characteristics it is similar to Ahwahnee coarse sandy loam, 9 to 15 percent slopes.

Included with this soil in areas near Dunlap and Miramonte are small areas of similar soils 4 to 6 feet deep to weathered parent rock. Some small areas of Auberry soils are intricately intermingled with these deeper included soils.

This soil is used only for grazing. It is ordinarily well suited to grazing, but some areas have a brush cover. Converting some of the brushy areas to grass is not practical, because slopes are steep and erosion is a serious hazard. Brush is most often removed from those areas that adjoin large areas of less steep soils.

Fertilizing this soil from the ground is a questionable practice because slopes are so steep that application is difficult. Capability unit VIIe-1 (18); range site 2; natural land type E11; Storie index rating 19

Ahwahnee very rocky coarse sandy loam, 8 to 30 percent slopes (AdD).—Areas of this soil are widely distributed in the part of the upper foothills occupied by Ahwahnee soils. It is similar to Ahwahnee coarse sandy loam, 9 to 15 percent slopes but, ordinarily, more than 10 percent of the surface of this soil is occupied by rock outcrop. From area to area, the rock cover ranges from 2 to 25 percent. The rock limits use of farm machinery to such extent that a wider range of slope was permitted in this soil than for some of the other Ahwahnee soils.

Some of the rock outcrops are prominent and rough or subrounded, and others are low and smooth. The prominent outcrops are 2 to 10 feet across and 2 to 8 feet high. These outcrops occur singly or in clusters, and many of the larger ones are jointed or fractured. The low rock exposures range from 10 to 50 feet in diameter, and few of them rise more than 2 feet from the surface. The exposed rock is light colored except where it has been coated by a gray or dark-gray growth of lichens.

This soil is mainly undulating and hilly. The hazard of erosion is slight to moderate, according to the arrangement of the rock outcrops. Where the outcrops produce a local terracing effect, runoff is slowed, but where large faces of rock are exposed, runoff is accelerated.

Included with this soil in mapping were areas near Black Mountain, Cold Spring Rancheria, and Pine Flat Reservoir where Auberry soils are complexly intermingled with this soil.

Less rocky areas of this soil are suited to forage. Brush removal for range improvement ordinarily is done only by burning because the rock outcrops make use of tractors to crush or bulldoze the brush either difficult or impractical. Applying fertilizer is practical, but spreading it is somewhat difficult. Many of the rock outcrops provide refuge and nesting sites for small wildlife. A few small areas have been selected as picturesque homesites. Capability unit VIs-1 (18); range site 2; natural land type E4; Storie index rating 27.

Ahwahnee very rocky coarse sandy loam, 30 to 45 percent slopes (AdE).—This is a rocky, steep soil on hills, ridges, and canyon slopes. It has a profile similar to that of Ahwahnee coarse sandy loam, 9 to 15 percent slopes. Areas are in the San Joaquin River canyon, in Morgan Canyon, and near Black Mountain, Pine Flat Reservoir, Tivy Mountain, and Bear Mountain.

Well-distributed rock outcrops cover 10 to 25 percent of the surface of this soil. Natural drainage of this soil is somewhat excessive. Runoff is rapid, and the hazard of erosion is high. Some of these outcrops are prominent and rough or subrounded; others are low and smooth. The prominent outcrops are 2 to 10 feet across and 2 to 8 feet high. They occur singly or in clusters, and many of the larger ones are jointed or fractured. The low rock exposures range from 10 to 50 feet in diameter, and few of them rise more than 2 feet from the surface. The exposed rock is light colored except where it has been coated by a gray or dark-gray growth of lichens.

Near Cold Spring Rancheria and Pine Flat Reservoir, small, intricately mingled areas of Auberry soils were mapped with this soil.

This soil is used for range and is suitable for forage production. Forage would respond well to fertilization, but application from the ground would be difficult and costly. Capability unit VIIs-8 (18); range site 2; natural land type E12; Storie index rating 12.

Ahwahnee very rocky coarse sandy loam, 45 to 70 percent slopes (AdF).—This very steep soil is on canyon slopes and ridges in the upper foothills. Rock outcrops occupy 2 to 50 percent of the surface. Where this soil skirts Table Mountain, its surface has a scattering of basaltic boulders that tumbled down from the cliffs.

Drainage of this soil is somewhat excessive. Runoff

is very rapid, and the erosion hazard is very high on unprotected slopes.

Included with this soil in mapping are areas near Pine Flat Reservoir and Cold Spring Rancheria where Auberry soils are intricately intermingled with this soil.

This soil is used for range, as part of a watershed, and for wildlife. It is suitable for forage except where it is very rocky. The steep slopes greatly reduce intensity of grazing, particularly by cattle. Overgrazing is seldom a problem, but less than full use of the available forage frequently is. Fire is a greater danger than overgrazing. If the vegetation is destroyed, the erosion is severe. Improvement of stock trails and planned location of salting sites are ways to increase use of the forage. Fertilization of the range is not practical. Capability unit VIIe-8 (18); range site 2; natural land type E12; Storie index rating 6.

Ahwahnee very rocky coarse sandy loam, shallow, 3 to 30 percent slopes (AeD).—Subrounded rock outcrops occupy 2 to 25 percent of the surface of this soil. These rocks are reasonably evenly distributed and, on the average, occupy somewhat more than 10 percent of the surface area.

The subsoil is somewhat thinner, but the profile of this soil otherwise is much like that described for the series. The soil ordinarily is 18 to 20 inches thick over weathered parent rock, but the range is from 18 to 24 inches. The subsoil is 8 to 14 inches thick.

The general drainage is somewhat excessive. Runoff is slow to rapid, and the hazard of erosion is variable but generally moderate. The available moisture holding capacity is very low.

This soil is used for annual range. In years of low rainfall, it is less suitable for forage than deeper Ahwahnee soils, as the plants tend to dry up earlier in the season. Range fertilization is practical, but the soil is too shallow and rocky for growing dry-farmed grain for hay. Capability unit VIs-4 (18); range site 2; natural land type E8; Storie index rating 15.

Ahwahnee very rocky coarse sandy loam, shallow, 30 to 70 percent slopes (AeF).—This steep to very steep soil is on canyon slopes and ridges near Millerton Lake, Marshall Station, Squaw Leap, and Tollhouse and in parts of the Sand Creek drainage. It occupies a large part of the headwaters of many small watersheds, where runoff during rainy periods contributes significantly to rise and flow of local intermittent streams.

Near Marshall Station, a body of this soil has blocks of basalt rock on its surface that tumbled from the cliffs nearby. Elsewhere, small areas of soils that are similar but nonrocky were included in mapping, and on the canyon slopes along the San Joaquin River some small bodies of Granitic rock land and Coarsegold soils.

This soil is suited to forage production and is grazed, but the intensity of grazing is less than on the less sloping Ahwahnee soils. Better use of forage can be encouraged by making stock trails and selecting undergrazed places for salt licks. Fertilizing the range is not practical, and large areas of this soil ordinarily are not included in projects to convert the type of plant cover. The rocks afford many refuges for wildlife. Capability unit VIIs-8 (18); range site 2; natural land type E16; Storie index rating 4.

Ahwahnee-Sierra coarse sandy loams, 15 to 30 percent slopes (AhD).—This complex occupies hilly parts of broad ridges lying between deeply incised canyons along small streams. It consists of Ahwahnee and Sierra coarse sandy loams so intricately intermingled that it is not practical to separate them at the scale used in mapping. Each of the two kinds of soil named makes up at least 20 percent of any given area, but the actual proportion differs from place to place. The areas of this complex are south and southeast of Pinehurst near the Tulare County line.

The profile of the Ahwahnee soil is similar to that described as typical for the series but uniformly deeper to weathered rock. The depth to rock is 48 to 72 inches. The profile of the Sierra soil is similar to that described under the Sierra series but somewhat coarser textured in the surface layer.

The soils of this complex are well drained. Runoff is medium to rapid, and the hazard of erosion is moderate to high. Permeability of the subsoil ranges from moderately rapid to moderately slow. The available water holding capacity of these soils is medium to high.

This complex is used for range, as watershed, and as natural habitat for wildlife. It supports a dense stand of brush and hardwoods that provides good cover for small wildlife. One area in a protected ravine supports a scattering of ponderosa pine and black oak. Unless the brush is removed, this complex provides only a little browse for livestock. Fertilization with nitrogen, and with phosphorus, sulfur, or both, is required to establish a good cover of forage. Capability unit VIe-1 (17, 18); range site 2; natural land type E3; Storie index rating 38.

Ahwahnee-Sierra coarse sandy loams, 30 to 45 percent slopes (AhF).—This complex consists of Ahwahnee and Sierra coarse sandy loams so intricately intermingled it is not practical to separate them at the scale used in mapping. Each kind of soil makes up at least 20 percent of any one area, but the actual proportion differs from place to place. This complex is south of Miramonte on the headwaters of Indian Creek and southeast of Pinehurst near the Tulare County line.

The soils of this complex are somewhat excessively drained. Runoff is rapid, and the erosion hazard is high.

The natural cover on these soils is dense brush and hardwoods, and here and there, scattered open areas that produce annual grass and forbs. The complex provides only limited browse and is useful mostly as watershed or for wildlife. A part of the complex has been cleared of brush, however, and a fair cover of forage established. Capability unit VIIe-1 (18); range site 2; natural land type E11; Storie index rating 20.

Ahwahnee-Tollhouse-Rock land complex, 45 to 70 percent slopes (AkF).—This complex occurs on hills and canyon slopes where very steep, very rocky Ah-

wahnee and extremely rocky Tollhouse soils are too intricately intermingled with Granitic rock land to be mapped separately. Each area contains 20 percent or more of each soil and Granitic rock land. This complex is southwest of Miramonte, southeast of the Baker Ranch headquarters, and on canyon slopes along the San Joaquin River south of Kerckhoff Lake.

The surface layer of both soils is coarse sandy loam. Rockiness varies from area to area. From 2 to 25 percent of the surface of the Ahwahnee soil is covered with rock outcrops and some nonrocky areas are included with this soil. From 10 to 50 percent of the Tollhouse surface is rock covered, but commonly more than 25 percent. These exposures of bedrock are low and smooth or are prominent, irregular, and subrounded. They range in diameter from about 2 to 70 feet. The depth to weathered rock ranges from 20 to 36 inches in the Ahwahnee soil; it is somewhat less than 20 inches in the Tollhouse soil. Granitic rock land in areas of this complex are one-half acre or more in size and have more than 50 percent of the surface covered by granitic rock.

General drainage is somewhat excessive to excessive. Runoff is very rapid, and the available moisture holding capacity is low. Both soils are moderately rapidly to rapidly permeable, and the hazard of erosion is very high.

The natural cover is dense brush and some hardwood trees. The complex is best used as a watershed and wildlife refuge. Some browse is available to livestock and deer. Conversion to grassland is not practical, though clearing to improve the browse is possible in some areas.

This complex is a hazardous fire area in summer. If it is burned over, it should be seeded to grass or other favorable plants that germinate quickly and provide protection against erosion in winter. Capability unit VIIs-8 (18); range site 10, natural land type E12; Storie index rating 5.

Aiken Series

The Aiken series consists of deep or very deep, well-drained soils that have a fine-textured subsoil. These soils formed in material weathered from basalt.

These soils occur on Stony Flat, a mesalike ridge that is a remnant of an old volcanic flow north of the community of Pinehurst. They are on both the steep side slopes and the undulating crest of Stony Flat, at elevations of 3,500 to 4,500 feet. The average annual temperature is 58° F.; the average growing season is about 150 days.

The natural vegetation consists of open to very open stands of ponderosa pine, some canyon live oak, and a scattering of shrubs such as bear-clover, mariposa manzanita, wedgeleaf ceanothus, and mountain-mahogany. Annual grasses and forbs cover the open areas. The steeper slopes have a dense cover of shrubs and trees.

In a typical profile, the surface layer is brown and dark brown loam about 9 inches thick. The subsoil to a depth of several feet is reddish brown and has a subangular blocky structure. The upper part is clay loam, but the main part of the subsoil is heavy clay. Weathered basalt underlies the soil at depths in excess of 4 feet. The entire profile is slightly acid to medium acid.

The Aiken soils are used mainly for pasture. In a few small areas there are some apple orchards, and in other small areas the soils are used for harvesting timber. Water is obtained from springs, intermittent small streams, and shallow wells drilled into the weathered basalt. Some shallow depressions on the more gentle slopes become ephemeral ponds during the rainy season.

Representative profile on a south-facing slope of about 9 percent under annual grasses and bear-clover, with widely scattered ponderosa pine and canyon live oak, at an elevation of about 4,275 feet (2 miles, airline, NE. of the village of Miramonte NW¼SW¼ sec. 14, T. 14 S., R. 27 E.):

O1 Thin, patchy accumulation of dried and partly decomposed stems and leaves of annual grasses and bear-clover.

A11—0 to 4 inches, dark-brown (7.5YR 4/2) loam, brown (7.5YR 5/4) when crushed and rubbed, dark reddish brown (5YR 3/2) when moist; strong, fine, granular structure; slightly hard when dry; friable when moist, slightly sticky and slightly plastic when wet, abundant fine and very fine roots, many fine, interstitial pores; slightly acid (pH 6.3); abrupt, wavy lower boundary.

A12—4 to 9 inches, brown (7.5YR 5/4) light clay loam, dark reddish brown (5YR 3/3) when moist; weak, fine, granular structure, slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet, plentiful fine and very fine roots, few medium roots, common medium to fine tubular pores, few fine rounded concretions of iron oxide, medium acid (pH 5.8); clear, wavy lower boundary.

B11t—9 to 21 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) when moist, weak, coarse, subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet, plentiful fine roots; common medium and fine tubular pores, few thin clay films on ped faces; common fine to medium concretions of iron oxide, medium acid (pH 5.8), clear, wavy lower boundary.

B12t—21 to 30 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) when moist, moderate, coarse, subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; few fine and medium roots; few medium and fine tubular pores, common thin clay films on ped faces; few fine and medium concretions of iron oxide; medium acid (pH 6.0); abrupt, wavy lower boundary.

B21t—30 to 84 inches, reddish-brown (5YR 4/4) heavy clay, yellowish red (5YR 3/6) when moist, strong, medium blocky structure; hard when dry, firm when moist, sticky and plastic when wet, very few fine and medium roots in upper part of horizon; continuous, moderately thick clay films on ped faces; few, medium tubular pores; medium acid (pH 5.9), diffuse, smooth lower boundary.

B22t—84 to 120 inches, reddish-brown (5YR 5/3) heavy clay, yellowish red (5YR 4/6) when moist, similar to B21t horizon in structure, consistence, clay film development, and reaction; diffuse, irregular lower boundary.

B3—120 inches +, reddish-brown to reddish-yellow clay and fragments of weathered basalt; clay has similar consistence and reaction to the B2t horizon, but is massive; grades to weathered basalt.

With the exception of soil depth, there is little variation in the profile characteristics. The depth of soil to weathered basalt ranges from about 4 to 12 feet.

Aiken loam, 3 to 9 percent slopes (AlB).—This soil occupies the broad ridgetop of Stony Flat. This soil has the profile described as typical for the series. The terrain is undulating to gently rolling for the most part. The natural vegetation consists mainly of grasses and forbs, but there are scattered ponderosa pines, canyon live oaks, and shrubs.

This soil is generally well drained. Runoff is slow to medium. Rainfall or snowmelt waters infiltrate the surface layer readily. Because the soil is slowly permeable, these waters move laterally downslope within the soil after heavy rains or during rapid snowmelt. Many ephemeral seeps generally appear on cut banks in sloping areas just above the subsoil during these periods. The available moisture holding capacity for plants is high; the hazard of erosion is moderate.

Included in mapping were areas of a soil that is much the same as this soil but has angular to subrounded outcrops and detached stones of the basaltic parent rock. Also included is a small acreage, near the southeastern end of Stony Flat, that has a rolling to hilly surface relief.

This soil is used mainly for pasture, but in some areas apples are grown. Scattered conifers are occasionally cut for lumber. The natural fertility of the soil is fair, but nitrogen and phosphorus are needed. The soil tends to tie up applied phosphorus fertilizers in a form unavailable to many plants. Capability unit IIe-1 (22); range site 1; natural land type E1; Storie index rating 68.

Aiken very rocky loam, 45 to 70 percent slopes (AmF).—This soil occupies the slopes below Stony Flat. The rockiness or stoniness is variable; from about 2 to 10 percent of the surface area is covered. The soil on the lower slopes has developed from stony colluvium that crept downslope, in part from a higher lying basaltic rockland rimming the edge of Stony Flat. Weathered granitic rock underlies the lower colluvial parts of this area.

This soil is well drained, but when saturated, runoff is medium or rapid, and the hazard of erosion is high. The natural vegetation generally consists of a dense cover of woodland shrubs, and there are conifers in some places. Some open grassy areas are located on western exposures.

This soil is used for limited browse. It is part of a small watershed and has value for wildlife use. Capability unit VIIs-1 (22); range site 1; natural land type E12. Storie index rating 9.

Alamo Series

The soils of the Alamo series are in small basinlike depressions on old alluvial terraces. The soils are poorly drained, dark colored clays. A cemented hardpan is at a depth of 20 to 48 inches. The parent material is loamy alluvium derived from either granitic or mixed rocks. The natural vegetation is annual grasses and herbs, or forbs.

The soils are widely distributed in numerous small areas and are closely associated with both the San Joaquin and Yokohl soils. Their elevation ranges from about 300 to 500 feet along the eastern edge of the San Joaquin Valley, from the vicinity of Friant to that of Orange Cove. The average annual precipitation ranges from about 10 to 15 inches. The average annual temperature is about 62° F. The frost-free season ranges from about 250 to 275 days. However, the depressed positions of the soils make them probable sites for cold pockets, where cold air draining from adjacent higher areas can be trapped.

Typically, the Alamo soils have a dark-gray to dark-brown slightly acid clay surface layer about 11 inches thick. The next layer is dark-brown, mottled, neutral to moderately alkaline clay to sandy clay. At a depth of about 23 inches is a strongly cemented hardpan of sandy material of varying thickness.

Alamo soils are used for dry pasture, irrigated pasture, and for dryfarmed barley. The latter use is normally in areas where these soils are closely intermingled with other soils that are used for dryfarming.

Representative profile in a flat depressional area at an elevation of about 400 feet, in fallow that has a scattering of weeds (70 feet NE. of the junction of Newmark and Ashlan Avenues in the SW¼SW¼SE¼ sec. 13, T. 13 S., R. 22 E.).

Ap—0 to 3 inches, dark gray (10YR 4/1) clay, very dark brown (10YR 2/2) when moist; strong, medium to fine, subangular blocky structure; very hard when dry, firm when moist, sticky and very plastic when wet; abundant very fine and microsize roots; slightly acid (pH 6.5); abrupt, wavy lower boundary.

A1—3 to 11 inches, dark-brown (10YR 3/3) clay, dark gray (10YR 4/1) in upper 2 inches of horizon; dark brown (10YR 3/2) when moist, very dark brown (10YR 2/2) in upper 2 inches of horizon; strong, coarse, prismatic structure breaking weakly to coarse angular blocky structure; very hard when dry, firm when moist, sticky and very plastic when wet; plentiful microsize roots; few very fine and medium tubular pores; moderate slickensides on some ped faces; strong slickensiding at base of structural prisms at angles of 22 to 30 degrees from horizontal; slightly acid (pH 6.5); abrupt, wavy lower boundary.

C1—11 to 15 inches, dark brown (7.5YR 3/2) clay, similar color when moist; very coarse, angular blocky structure; very hard when dry, firm when moist, sticky and very plastic when wet; few microsize roots; very few fine and medium tubular pores; few pressure faces and slickensides; moderately alkaline (pH 8.0); clear, smooth lower boundary.

C2g—15 to 23 inches, dark brown (7.5YR 3/2) sandy clay, similar color when moist; common, fine, prominent mottles of reddish yellow (7.5YR 6/6 and 6/8), yellowish red (5YR 5/6 and 5/8) when moist; similar to C1 horizon in structure, consistence, root development, pore structure, slickensides, and reaction; very abrupt, wavy lower boundary.

IIC3m—23 inches +, strong-brown and reddish yellow (7.5YR 5/6 and 6/6) hardpan, yellowish red and dark reddish brown (5YR 5/6 and 3/4) when moist; black manganese dioxide staining on upper surface and in mass of pan; coarse platy structure; strongly cemented sandy material; dense; grades with depth into weakly cemented but densely packed sandy material.

The color of the A horizon is generally dark gray or dark grayish brown (10YR 4/1, 4/2), but is grayish brown or dark brown (10YR 5/2, 3/3) in places. The moist color

ranges from very dark gray to very dark brown or dark brown (10YR 3/1, 2/2; 7.5YR 3/2). The texture of the A horizon and of the C horizon above the hardpan is typically clay. In undisturbed areas the soil appears massive, but many vertical cracks, ½ to 1 inch wide, divide the surface into large polygonal blocks. The subsurface soil acquires a coarse to very coarse prismatic structure from the vertical cracking. In areas that are cultivated, the Ap horizon is rough and cloddy, but the clods may break into finer, angular or subangular blocky fragments. The reaction of the surface layer ranges from neutral to slightly acid.

The color of the C horizon above the hardpan is dark gray, very dark grayish brown, or dark brown (10YR 4/1, 3/2; 7.5YR 3/2). Few to common mottles of strong brown to yellowish red or reddish yellow are developed a few inches above the hardpan. The C horizon is generally massive. Some vertical cracking develops on thorough drying. The reaction ranges from neutral to moderately alkaline. Lime is present in some places. [illegible] segregated in small, hard nodules [illegible].

The hardpan layer (IIC3m horizon) is strongly cemented with iron and silica, and in some places [illegible] lime cementation. In places the pan consists of weakly cemented but very compact sandy material, similar to the material that normally lies below the more strongly cemented hardpan. [illegible] generally depends on the kinds of cementing agents. Where lime is lacking, the colors are reddish and range in random variegation from strong brown to dark reddish brown. Lime tends to lighten the colors and make them somewhat more yellowish. The more strongly cemented hardpan has coarse platy structure; the less strongly cemented part [illegible]. The depth to the hardpan layer ranges mainly from about 20 to 48 inches. In a few places, however, the hardpan is as shallow as 15 inches.

Alamo clay (0 to 2 percent slopes) (An).—This is the only Alamo soil mapped in the area. This soil is nearly level, and it is seasonally poorly drained. There is little or no runoff during the rainy season, except where the soil is in sluggish drainageways. Above the hardpan the soil is very slowly permeable. Where the hardpan is well formed it is almost impermeable to roots, water, and air. Ponding of surface water often occurs during the winter and spring. This water evaporates and the soil dries late in spring and in summer. The available moisture holding capacity ranges from low to medium, depending on the depth to the hardpan. Erosion is not a hazard.

This soil is near Round Mountain and in the vicinity of Citrus Cove. Near Orange Cove the soil has been mapped in complex with San Joaquin loam.

Included with this soil in mapping were small areas of similar soils that have a clay loam surface layer. Some of these inclusions have a low hummocky microrelief.

The natural fertility of Alamo clay is fair, but its clayey texture and poor drainage limit its suitability for crops. In addition, this soil is deficient in nitrogen and phosphorus. Cultivation of this soil is difficult because of its texture. The plow layer forms very hard clods when dry and is sticky and heavy when wet. This soil is generally cultivated with the better drained, sandy or loamy soils. As a consequence, it is usually too dry or too wet to remain in good tilth. Implements can become mired in this soil when it is very wet.

Dryfarmed barley has been the principal crop grown on this soil. In some areas range pasture has been included in rotation with fallow. In wet years the barley is often partly or wholly drowned out, while in dry years the growth of crops may be fairly good while the surrounding sandier soils produce very little. Many of the larger areas of this soil are used for irrigated pasture. Because of poor drainage, excess irrigation water can cause rapid deterioration of the pasture. Capability unit IIIw-5 (17, 18); range site 2; natural land type C14-1o; Storie index rating 12.

Atwater Series

The Atwater series consists of deep, well-drained, coarse textured and moderately coarse textured soils that formed in stabilized old dunes of wind-sorted material. This material was blown from dry, sandy streambeds or other areas of sandy, granitic alluvium. Under natural conditions the soils are undulating to rolling.

Areas of these soils lie in a northwest-southeast position, parallel to the prevailing wind direction. They are commonly located on the lee side of stream channels that flow southwesterly, such as those of Fancher Creek and Dry Creek near Clovis, Fresno, and Sanger. Many areas of these soils are similarly located in relation to many small streamways in the Reedley-Navelencia district. The soils range in elevation from about 250 to 450 feet. The average annual precipitation ranges with elevation from 9 to 14 inches. The average annual temperature is about 62° F. The growing season ranges from about 250 to 275 days. Natural vegetation consists of annual grasses and forbs.

Typically, the Atwater soils have a light brownish-gray to dark grayish-brown loamy sand surface layer about 24 inches thick. The subsoil is brown sandy loam about 19 inches thick that offers only a slight restriction to the penetration of roots and water. Beneath the subsoil is a light yellowish-brown loamy sand extending to a depth of about 60 inches where it is underlain by a compact cemented sandy material that is indefinite in thickness.

Under irrigation, the Atwater soils are used for vineyards, fruit and nut trees, truck crops, cotton, and alfalfa (fig. 4). No dryfarmed crops are grown on this soil, and very little, if any, of this soil is used for range or dry pasture.

Representative profile in a nearly level, fallow field supporting a scattered cover of annual grasses and forbs and some bermudagrass, at an elevation of 387 feet (about 2¼ miles, N. of Sanger, 120 feet NW. of the crossing of East Branch Ditch and Academy Avenue in the SE¼NE¼SE¼ sec. 34, T. 13 S., R. 22 E.):

Ap—0 to 9 inches, light brownish-gray (10YR 6/2) loamy sand, dark grayish brown (10YR 4/2) when moist; [illegible] that breaks easily [illegible] grain; slightly hard to loose when dry, very [illegible] few fine to very [illegible] and very few [illegible] roots; abundant very fine and microsize interstitial pores; slightly acid (pH 6.5); abrupt, wavy lower boundary.

A[illegible]—9 to 24 inches, light grayish-brown (10YR 6/2, 5/3) loamy sand, dark brown to dark yellowish brown (10YR 3/3, 4/4) when moist; massive, but breaks easily to single grain; slightly hard when dry, very friable when moist; very few fine roots, few fine tubular pores, and abundant very fine and mi-

Figure 4.—Windrowed alfalfa hay on an Atwater sandy loam.

microsize interstitial pores, several ¼ inch fibers with sandy loam texture, some clay coating of grains and clay bridging in fibers, slightly acid (pH 6.5); abrupt, wavy lower boundary.

B2t—24 to 43 inches, brown (7.5YR 5/4) sandy loam, dark brown (7.5YR 4/2, 4/4) when moist; weak, coarse angular blocky structure; hard when dry, friable when moist, slightly sticky and nonplastic when wet; very few fine roots; few to common tubular pores, abundant microsize interstitial pores, occasional small krotovinas; few thin clay films on ped faces, grain coatings, and pore fill; neutral (pH 7.0); abrupt, irregular lower boundary.

C1—43 to 60 inches, light yellowish-brown (10YR 6/4) loamy sand, dark brown (10YR 4/3) when moist; massive, but breaks readily to single grain; slightly hard to loose when dry, very friable when moist; occasional fine roots; abundant very fine and microsize interstitial pores, slightly acid (pH 6.5); very abrupt, wavy lower boundary.

IIC2—60 inches +, dark-brown, massive, weakly indurated layer formed in moderately coarse textured alluvium; very hard when dry, firm to brittle when moist, several feet thick.

The A horizon ranges from grayish brown to light brownish gray to pale brown (10YR 5/2, 6/2, 6/3) in color. When moist, the colors darken slightly to dark grayish brown or dark brown (10YR 4/2, 4/3). The texture ranges from loamy sand to sandy loam. The horizon is generally massive but in some places is single grain. Dry consistence ranges from loose to hard. The reaction ranges from neutral to slightly acid. The A horizon grades clearly into the Bt horizon, or abruptly through a series of thin fibers or layers of material like the Bt horizon.

The Bt horizon is brown or dark brown (7.5YR 5/4, 4/4, 10YR 5/3, 4/3). The moist color is generally dark brown (7.5YR 4/2, 4/4) but in places is brown, yellowish brown, or dark yellowish brown (7.5YR 5/4; 10YR 5/4, 4/4). The Bt horizon is massive or has weak angular blocky structure. The dry consistence is hard or very hard. The reaction ranges from neutral to slightly acid. In places the Bt horizon occurs as two or more thin, distinct horizons that are 4 to 8 inches thick and are separated by layers of C horizon material of similar thickness.

The C horizon is light yellowish brown, yellowish brown, or brown. The texture ranges from loamy sand to sandy loam. In places it appears to be stratified alluvium, unmodified by wind. Typically it is massive, although layering from stratification or cross bedding is commonly apparent in exposures. Dry consistence ranges from loose to slightly hard or hard. The reaction ranges from slightly acid to mildly alkaline. This horizon is permeable and may be many feet thick or rest abruptly on an unrelated, dense substratum within 60 inches of the surface.

Atwater loamy sand, 0 to 3 percent slopes (AoA).—A profile of this soil is described as typical for the series. Areas of this soil in many places lie close to sandy intermittent streambeds. The surface ranges from nearly level to gently undulating.

The surface layer is typically loose or slightly hard when dry and ranges from light brownish gray to pale brown in color. The depth to an unrelated, compact layer can be as shallow as 60 inches, but is normally deeper than 72 inches.

Runoff from this soil is very slow because of the gentle slopes and moderately rapid permeability. The available moisture holding capacity for plants is low. The natural fertility is moderately low. The hazard of erosion from surface water is negligible, but soil blowing can be a moderate to severe hazard for areas unprotected during infrequent periods of high winds. At such times, seedlings emerging in cleanly tilled fields are subject to severe damage from windblown sand.

The soil is well suited to irrigated grapes, particularly raisin varieties, and to irrigated field crops such as alfalfa and cotton. It is fairly well suited to peaches and plums and to oranges where the soil lies within the zone of minimum frost hazard. Most areas of this soil have been smoothed and graded to improve management of irrigation water. Ungraded areas planted to field crops are generally irrigated by a sprinkler system. Fruit crops planted in ungraded areas are irrigated through gated openings from a pipeline distribution system that feeds short runs or by contour checks. Shallow rooted crops require frequent irrigation. Nitrogen fertilizer is required for all crops except alfalfa. It is sometimes used at planting time to stimulate early growth of young alfalfa plants. Phosphorus is needed for all field crops and is used in vineyards. Leguminous crops like alfalfa are stimulated by sulfur applied as gypsum, or through the use of superphosphate fertilizers. Capability unit IIIs-4 (17); range site not assigned; natural land type A5; Storie index rating 70.

Atwater loamy sand, 3 to 9 percent slopes (AoB).—This soil is gently rolling; except for its surface relief, it is similar to Atwater loamy sand, 0 to 3 percent slopes. It formed in dune-like deposits of windlaid material. Areas of this soil are on isolated low knolls or on long, low ridges lying on the lee side of the channels

of many intermittent streams or abandoned stream courses.

Because of its slope and a subsoil that slows water penetration slightly, the hazard of erosion by water is slight to moderate. Soil blowing can be a moderate to severe hazard in unprotected areas during infrequent periods of high wind.

Areas of this soil are located in the vicinities of Navelencia, Reedley, Sanger, Fresno, and Clovis, and near the Dry Creek flood control reservoir.

Included with this soil in mapping were small areas where the slope is as steep as 15 percent. Also included are other small areas of a similar soil that has a hard substratum at a depth ranging from 3 to 4 feet.

Table and raisin grapes, plums, oranges, some peaches, and cotton are grown on this soil. Many areas of the soil are leveled or terraced before planting. In places, leveling has completely destroyed the natural soil profile and has replaced it with a deep, uniform, light sandy loam. In other places, leveling exposes deeply buried unrelated loamy soil material or cemented sandy layers that must be ripped and broken. Organic matter needs to be built up in such newly exposed soil materials, and fertilization with nitrogen and phosphorus is necessary.

Fruit crops planted in unleveled areas of the soil are irrigated by means of contour furrows. Many areas of this soil in the Reedley-Navelencia area adjoin other similar soils of the Atwater series and together form extensive low ridges. Distributory canals of the Alta Irrigation District have been built on these ridges. Capability unit IIIs-4 (17); range site not assigned; natural land type A6; Storie index rating 65.

Atwater loamy sand, moderately deep, 0 to 3 percent slopes (AnA).—The profile of this soil differs from that described as typical for the series because the subsoil lies very abruptly at a moderate depth on a thick, compact, variably cemented, sandy substratum. The substratum is unrelated to the overlying soil. It is slowly permeable and very hard to extremely hard when dry, but it is brittle or firm when moist. The depth to the substratum ranges from about 2 to 5 feet, but is most commonly 3 to 4 feet. The downward movement of roots or water is seriously restricted by the substratum. A zone of saturation is developed above the substratum if the soil is overirrigated or subjected to a prolonged rainy period. In a few places the substratum consists of a hardpan similar to that of the San Joaquin soils, and in some places it is dark-colored, very slowly permeable clay.

Areas of this soil are located between Fresno and Sanger in the general vicinity of Fancher Creek.

The principal uses of this soil are for vineyards and some cotton and alfalfa. Fruit trees are not well suited to the soil, because of the restricted drainage. The available moisture holding capacity is very low. Frequent irrigation is required to maintain the available moisture above the wilting point. This is particularly important for cotton. Care must be taken, however, to avoid overirrigation and the consequent drowning out of roots from excess water perched on the substratum. In places where the substratum is relatively close to the surface, deep chiseling or ripping can break parts of the substratum and improve the internal drainage. Capability unit IIIs-3 (17); range site not assigned; natural land type A11; Storie index rating 52.

Atwater sandy loam, 0 to 3 percent slopes (ArA).—This soil has a profile similar to that described for the series except that it has a sandy loam surface layer. It is gently undulating. In outline, it shows a strong tendency toward a lobed pattern extended in the direction of the prevailing winds, or it lies in the position of a longitudinal dune on the lee side of a sandy streamway.

The available moisture holding capacity ranges from low to moderate, and the hazard of soil blowing is less severe than on the Atwater loamy sands. Runoff is slow, and erosion from moving water is negligible.

This is the most extensive of the Atwater soils and is located in the Reedley-Orange Cove District, and in the vicinities of Sanger, Clovis, Fresno, and Kearney Park.

Included with this soil in mapping were very similar soils that have a subsoil of sandy clay loam instead of sandy loam or heavy sandy loam.

This soil is suited to, and is used for, a wide variety of fruit and field crops. It responds to the use of both nitrogen and phosphorus fertilizers. Irrigated legumes on this soil will probably respond to sulfur. Capability unit IIs-4 (17); range site not assigned; natural land type A1; Storie index rating 86.

Atwater sandy loam, 3 to 9 percent slopes (ArB).—This soil is similar to Atwater sandy loam, 0 to 3 percent slopes, except that it is undulating. Runoff is medium, and the hazard of water erosion is slight to moderate.

This soil is located in the vicinity of Navelencia, along the sides of the small stream valleys of Red Bank Slough and Fancher Creek, and near Clovis.

Included with this soil in mapping were areas of similar soils, along parts of the small stream valleys, that have somewhat steeper slopes.

This soil is used for vine crops and fruit trees. Irrigation water is applied in contour furrows, or in short runs from gated outlets in irrigation pipelines. Many areas of this soil have been leveled or terraced and planted to fruit crops or cotton. The original soil profile is completely or partly destroyed in these operations, and this leaves a deep sandy loam that contains randomly mixed, harsh clods of subsoil material, or an exposed subsoil that requires some additional working to produce a good seedbed. With the addition of nitrogen and phosphorus fertilizers, and an increase in the content of organic matter in the surface layer, crops grow about as well on this soil as they do on undisturbed soils. Capability unit IIe-1 (17); range site not assigned; natural land type A1; Storie index rating 81.

Atwater sandy loam, clay substratum, 0 to 3 percent slopes (AsA).—This soil is similar to Atwater sandy loam, 0 to 3 percent slopes, but has an unrelated, dense, clay substratum at a depth of 2 to 4 feet. The clay is dark colored and very slowly permeable. It

can readily retard the movement of excess irrigation water or stormwater and thereby forms a saturated layer in the overlying soil. Some reddish or yellowish mottles in the subsoil are generally discernible within a few inches of the substratum. The drainage is slower in this soil than in those Atwater soils that are underlain by a hard substratum.

This soil is between Redbank Slough and Fancher Creek southeast of Clovis.

It is used largely for field crops, irrigated pasture, and some vineyards. It is not suitable for fruit trees unless adequate drainage is provided for removing excess water that is accidently applied. Capability unit IIIs-3 (17); range site not assigned; natural land type A9; Storie index rating 53.

Atwater sandy loam, moderately deep, 0 to 3 percent slopes (AIA).—This soil is similar to Atwater sandy loam, 0 to 3 percent slopes, except that it has a thick, hard, unrelated substratum of compacted, weakly cemented, sandy material that underlies this soil at a moderate depth. The depth of soil over the substratum generally ranges from about 3 to 4 feet, but in some places it is as shallow as 2 feet.

Areas of this soil are northeast of Reedley, north of Del Rey, along Fancher Creek, and in the vicinities of Clovis and Fresno.

Included with this soil in mapping are soils that are similar to this soil but have a subsoil of sandy clay loam rather than sandy loam. Also, in places there are small areas that are lacking a substratum within 5 feet of the surface. Where areas of this soil lie in small stream valleys, small inclusions are moderately sloping.

The available moisture holding capacity is low because the penetration of roots is restricted by the hard substratum. Except for the moderately sloping areas that were included in the mapping, runoff is very slow, and there is little or no hazard of erosion. For the included soils, runoff is medium and the hazard of erosion is slight to moderate.

The use and management of Atwater sandy loam, moderately deep, 0 to 3 percent slopes, is similar to that for Atwater loamy sand, moderately deep, 0 to 3 percent slopes. The somewhat greater available moisture capacity reduces the frequency for applying controlled amounts of irrigation water. Fruit trees are grown on this soil successfully where internal drainage can be improved by deep ripping and where there is careful control of the amount of irrigation water applied. Capability unit IIIs-3 (17); range site not assigned; natural land type A9; Storie index rating 65.

Auberry Series

The Auberry series consists of moderately coarse textured soils derived from granitic rocks in the upper foothills. These soils are well drained to somewhat excessively drained and have a thick, brown, moderately fine textured subsoil. They are moderately deep or deep to strongly weathered quartz diorite that is relatively low in dark-colored, iron bearing minerals. These soils are mainly undulating to hilly, but some areas occur on canyon slopes and on the steep or very steep slopes of prominent hills or ridges. Rock outcrops are common, but less than half of the acreage contains enough rock outcrops to be mapped as rocky. About one-half of the rocky areas have slopes that are less than 30 percent.

The Auberry soils are mainly north of the Kings River. They are for the most part at elevations of 1,000 to 3,500 feet, but in some protected canyons they are at elevations as low as 500 feet. According to elevation, the average annual precipitation ranges from 18 to 32 inches; average annual temperature from about 56° to 60° F.; and average growing season from 150 to 225 days.

The vegetation is mainly trees and grass or trees, grass, and shrubs, but some areas are in open grassland. The trees are mainly blue oak, interior live oak, and California buckeye, but there is some valley oak. There is also some Digger pine, but it grows only north of the Kings River. The shrubs are mainly wedgeleaf ceanothus, chaparral whitethorn, mariposa manzanita, scrub oak, poison-oak, and other shrubs that form chaparral. The grassland consists of annual grasses and forbs.

In a typical profile, the surface layer is slightly acid, grayish-brown, and pale-brown coarse sandy loam about 12 inches thick. The subsoil is mainly compact, brown sandy clay loam that has blocky structure. The reaction is medium acid. Deeply weathered parent rock underlies the subsoil at a depth of about 42 inches.

The Auberry soils are used mainly for annual range, but they are also important for local watersheds and wildlife. Some dryfarmed grain is raised for hay in gently sloping areas. In recent years areas of these soils have been used for turkey ranching. Areas of these soils having slopes of less than 30 percent and located near the upper elevational range of the series have a potential as sites for Christmas trees. A source of supplemental water is desirable to hedge against periods of low rainfall. Because of a growing need for homesites, some areas of Auberry soils are being diverted to country residential use. Water for domestic use and for livestock is obtained from springs, intermittent streams, and a few perennial streams. Small earthen dams on the intermittent streams help to lengthen the season during which surface water is available. Water is also obtained from shallow wells in the deeply weathered rock or in alluvium along small streams.

Representative profile on a northwesterly slope of about 5 percent, in an undulating to gently rolling area under annual grasses and forbs in an area of rangeland supporting an open stand of trees, grasses, and shrubs in which 5 to 10 percent of the area is studded with parent rock outcrops, at an elevation of about 2,150 feet (½ mile W. of New Auberry on S. side of Power House No. 1 Road in the NW¼NW¼NE¼ sec. 6, T. 10 S., R. 23 E.)

O1—¼ inch to 0, litter of light grayish-brown annual grass and parts of forbs; loose when dry, mats weakly when moist.

A1—0 to 7 inches, grayish-brown (10YR 5/2) coarse sandy loam, dark brown (10YR 3/3) when moist; moder-

ate, fine to medium, granular structure; slightly hard when dry, friable when moist; abundant fine roots; many fine tubular pores; slightly acid (pH 6.2); clear, smooth lower boundary.

A3—7 to 12 inches, pale brown (10YR 6/3) coarse sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium to fine, subangular blocky structure; hard when dry, friable when moist; nonsticky and nonplastic when wet; slightly more compact and less porous than A1 horizon; few fine and medium roots; medium acid (pH 6.0); clear, smooth lower boundary.

B1t—12 to 18 inches, brown (10YR 5/3) heavy sandy loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; slightly sticky and nonplastic when wet; few fine and medium roots; few, fine tubular and common very fine interstitial pores; appreciable sand grains coated and bridging with clay; medium acid (pH 6.0); clear, smooth lower boundary.

B2t—18 to 35 inches, brown (10YR 5/3) light sandy clay loam, dark yellowish brown (10YR 4/4) when moist; moderate, coarse to very coarse, angular blocky structure; very hard when dry, firm when moist; slightly sticky and slightly plastic when wet; common moderately thick clay films on ped faces; very few fine and medium roots; very few fine tubular pores; strongly acid (pH 5.3); abrupt, smooth lower boundary.

B3—35 to 42 inches, pale-brown (10YR 6/3) coarse sandy loam, yellowish brown (10YR 5/4) when moist; weak, medium to fine, subangular blocky structure; slightly hard when dry, friable when moist; slightly sticky and nonplastic when wet; highly micaceous; few thin clay films on ped faces; many very fine and microscopic interstitial pores; medium acid (pH 6.0); abrupt, wavy lower boundary.

C—42 to 60 inches +, very pale brown, peppered with dark-gray, strongly weathered quartz diorite; variegated yellowish brown to dark gray when moist; granitic rock fabric clearly visible; easily excavated material crushes to a loamy coarse sand; many very fine and microscopic interstitial pores between mineral grains; neutral (pH 6.8); continues many feet to unweathered parent rock.

The color of the A1 horizon is typically grayish brown (10YR 5/2) but is dark grayish brown or brown (10YR 4/2, 5/3) in places. Moist colors may be dark brown, very dark brown, or very dark grayish brown (10YR 3/3, 2/2 or 3/2). The structure is commonly granular, but where it is heavily trampled by grazing animals it becomes massive and hard when dry. The reaction ranges from slightly acid to medium acid. The thickness of the A1 horizon ranges from about 5 to 10 inches.

The Bt horizon is generally brown or yellowish brown (7.5YR 5/4, 10YR 5/3, 5/4) when dry but in places it is pale brown or light yellowish brown (10YR 6/3, 6/4). When moist it is dark brown or dark yellowish brown (7.5YR 4/4, 10YR 4/3, 4/4). The texture of the B2t horizon is mainly sandy clay loam but is heavy sandy loam in places. Transition horizons are somewhat coarser in texture. The structure of the B horizon is generally angular blocky but in some places this horizon is massive. The reaction ranges from medium acid to strongly acid.

The C horizon is quartz diorite that has been deeply weathered and that rapidly becomes harder and grades to essentially unweathered parent rock. The fabric of the parent rock is always clearly visible in the C horizon. The thickness of the C horizon is commonly more than 5 feet but where observed in road cut it is generally not more than 40 feet to unweathered rock. Depth of soil to the C horizon generally ranges from 30 to 48 inches, but in some places it is as much as 72 inches and in other areas as little as 15 inches.

Auberry very rocky coarse sandy loam, 3 to 30 percent slopes (AvD).—This soil has a profile similar to the one described as representative of the series. Slopes range from undulating to hilly.

Rock outcrops are varied in distribution and shape. From area to area, the rock cover ranges from 2 to 25 percent. The outcrops range in color from light gray to dark gray. The actual rock is light gray, speckled with black flecks of iron-bearing minerals. The growth of lichens over much of the rock surface gives it a darker tone. Many of the outcrops are subdued and subrounded, but some are subangular. The outcrops range from about 2 to 100 feet across and 10 to 15 feet high. The depth of soil is not in all places shallower adjacent to the outcrops.

This soil is well drained. The permeability of the subsoil is moderate. Runoff is slow to medium, but it varies according to the rock outcrops and slope gradient. The hazard of erosion ranges from moderate to high. The available water holding capacity ranges from medium to high.

Included with this soil in mapping were small areas, mainly in open grassy sites, of a similar soil in which the color value of the surface layer is no darker than 4 when moist. Also included are small island areas of higher and steeper Coarsegold soils and areas of other soils formed from basic igneous rocks. Adjacent to these latter inclusions, colluvial materials from them have imparted a reddish color to the subsoil. There are also included in some places small areas of rocky Ahwahnee soils, as well as dark Tollhouse soils. There are also small areas of Visalia and Chualar soils, which lie along small streams that drain areas of this Auberry soil.

The principal use of this soil is for rangeland. Except for very small areas, this soil is too rocky to be used for dryfarming grain to be cut for hay. This soil is an important part of small, local watersheds and offers a variety of habitats for many forms of wildlife. An increasing number of areas are being used for country homesites. In places the rockiness adds a natural landscaping value to some sites.

In open grasslands the rockiness does not greatly reduce the amount of natural forage production. However, in areas of brush, it is difficult to use tractors to flatten the brush in order to burn it and convert the area to grass. In places it is impractical for mechanical equipment to work. The brush may be removed by controlled burning without crushing, or areas of brush may be left as browseland, retaining also its value for wildlife. Brush control is increasingly important in minimizing the fire hazard near country homesites.

The forage on this soil responds well to nitrogen and phosphorus. The growth of legumes improves markedly with the application of sulfur in the form of gypsum or in superphosphate fertilizers, but the rockiness of the soil makes mechanical application difficult. Capability unit VIs-1 (18); range site 2; natural land type E4; Storie index rating 25.

Auberry coarse sandy loam, 3 to 9 percent slopes (AuB).—This soil is similar to that described as typical for the series but lacks the surface rockiness. It is

undulating to gently rolling. Runoff is slow or medium, and the hazard of erosion is moderate.

This soil occurs throughout the upper foothills in upland valleys and in other gently sloping areas. Depth of soil to weathered rock in most places ranges from about 36 to 48 inches, but in the vicinity of Auberry, Pine Flat Reservoir, and Miramonte, some areas of this soil have a depth in excess of 48 inches.

Included with this soil in mapping were areas at the base of Table Mountain, near Marshall Station, where the surface is stony. The stones are angular blocks that tumbled from a basalt rimrock above.

The natural cover is open grassland or an open stand of trees and grass. Most areas of this soil are cultivated and used for dryfarmed grain cut for hay. Where enough water is available, some irrigated pastures have been developed by irrigating with sprinklers or by using contour ditches, from which the water is allowed to flood downslope for short distances. The soil is also used for improved dry pasture, and for rangeland where it is not readily accessible. Applying fertilizer is practical. Capability unit IIIe–8 (18); range site 2; natural land type E3; Storie index rating 44.

Auberry coarse sandy loam, 3 to 9 percent slopes, eroded (AuB2).—The profile of this soil is similar to that described as typical for the series, but it lacks the surface rockiness. Also, this soil has been affected by sheet and gully erosion, for it was previously overgrazed or was used for dryfarmed grain cut for hay.

The crests of many knolls have lost an appreciable amount of surface soil. Gullies that have formed are V-shaped, 50 to 150 feet apart, and 1 to 3 feet deep, and they have a minor dendritic pattern of development. Some gullies were natural drains that have been deepened, and others have been cut into normal slopes. In uneroded areas, the soil is 40 to 60 inches deep to weathered parent rock. This soil is in the vicinity of Dunlap. Runoff is slow to medium, and the erosion hazard is moderate.

Included with this soil in mapping is an area of complexly intermingled Auberry and Ahwahnee soils that are similarly eroded and have similar relief.

At present this soil is used only for range pasture. Previously cultivated fields have been returned to a natural grass cover. Most gullies are no longer active and have been stabilized. Some sheet erosion continues in local sites. These areas are trampled and used as bedding grounds by small numbers of cattle.

This soil is suited to managed pasture. Fertilization is practical and would greatly improve the forage cover, which would stabilize the gullies and areas of sheet erosion. Country homesites are increasing in number in areas of this soil. If the soil is diverted to this use, site development should be so planned that the stabilized erosional scars are not reactivated. Capability unit IIIe–8 (18); range site 2; natural land type E3–3m; Storie index rating 36.

Auberry coarse sandy loam, 9 to 15 percent slopes (AuC).—The profile of this soil is similar to that described as typical for the series but lacks the surface rockiness. This rolling soil occurs on low hills in the upper foothills. South of the Kings River, in the vicinity of White Deer Flat, Dunlap, and Miramonte, the soil is deeper than in most areas; it ranges from about 4 to 6 feet in depth to weathered parent rock. Runoff is medium, and the erosion hazard is moderate.

Most areas of this soil are used as rangeland. This soil is easily managed and responds well to fertilization. In some areas the woody vegetation is dense enough to need clearing. In the vicinities of the communities of Auberry, Tollhouse, and Dunlap, many areas of this soil are used for dryfarmed grain grown for hay, or for dry pasture. Several turkey farms have been established on this soil near these communities. More care is required in the cultivation of this soil to reduce the hazard of erosion. Where there are turkey pens on slopes this soil needs systems of shallow interception drains across the slope to reduce the rilling and sheet erosion that can develop during the rainy season when the surface has been stripped bare and packed. Capability unit IVe–8 (18); range site 2; natural land type E3; Storie index rating 42.

Auberry coarse sandy loam, 9 to 15 percent slopes, eroded (AuC2).—The profile of this soil is similar to that described as typical for the series but lacks the surface rockiness. This unit is only in the vicinities of Tollhouse and Dunlap. The soil is eroded as a result of many years of growing grain for hay for local freight and stagecoach teams in earlier times. Runoff is medium, and the erosion hazard is moderate.

Most areas are now used for range or pasture, but some continue to be used for hay. Areas used for hay show moderate sheet erosion, rilling in some places but no gullying. Stubble mulching across the slope during periods of fallow and cross-slope seeding help to minimize erosion losses. This soil responds well to fertilization. Capability unit IVe–8 (18); range site 2; natural land type E3–3m; Storie index rating 34.

Auberry coarse sandy loam, 15 to 30 percent slopes (AuD).—The profile of this soil is similar to that described as typical for the series but lacks the surface rockiness. This soil normally has hilly relief. Although it is not densely covered by woody vegetation, this soil generally has a somewhat less open cover of oaks and shrubs than the less sloping Auberry coarse sandy loams.

This mapping unit is distributed throughout the upper foothills formed from granitic rock. Runoff is medium to rapid. The erosion hazard is moderate to high.

Included with this soil in mapping were minor areas of Ahwahnee soils. Several areas of deeper soils very similar to this unit have also been included. In these deeper areas, the thick subsoil grades into weathered rock at a depth ranging from about 50 to 70 inches. These included soils are located in the vicinity of Miramonte.

Because of the moderately steep slope and the hazard of erosion, little of this soil is cultivated. It is used almost entirely for range and is well suited to this use. Large areas of this soil constitute important segments of local watersheds. Forage crops respond to fertilization. Surface application of fertilizer is prac-

tical. Capability unit VIe-1 (17, 18); range site 2; natural land type E3; Storie index rating 37

Auberry coarse sandy loam, 15 to 30 percent slopes, eroded (AuD2).—This soil has a profile similar to that described as typical for the series, but it lacks the surface rockiness. This soil has been appreciably affected by sheet and rill erosion. Gullies have developed in only a few places, and these are generally overdeepened natural drains. Runoff is medium to rapid, and the erosion hazard is medium to high.

All areas of this soil are in the vicinity of Dunlap and have been used, or are now used for turkey farms. Intercepting drains built across the slope would shorten the length of wash of surface water and reduce erosion of the bare surface soil in turkey runs or pens. Capability unit VIe-1 (17, 18); range site 2; natural land type E3-3m; Storie index rating 26.

Auberry coarse sandy loam, 30 to 45 percent slopes (AuE).—This soil has a profile similar to that described as typical for the series but lacks the surface rockiness. This steep soil occupies hills, ridges, and nonrocky canyon slopes throughout much of the upper foothills. The vegetative cover is typically trees, shrubs, and grass. The woody species, mainly oaks and chaparral shrubs, range in surface cover density from about 30 to 80 percent. Some south-facing slopes are open grasslands, whereas other protected or north facing slopes are almost completely covered with woody vegetation. Soil depth to weathered parent rock is seldom greater than about 40 inches. A very minor area of this soil with a depth greater than 48 inches is southeast of Miramonte.

Natural drainage is somewhat excessive, and runoff is rapid. The hazard of erosion is high for unprotected surfaces.

The principal use of this soil is for annual range. The soil is well suited to this use, but some areas are less usable because of their cover of woody vegetation. Range improvement programs that involve converting the plant cover to grass normally are not suited to soils with slopes as steep as this one, because of the hazard of erosion. However, such improvement can be done where this soil is adjacent to large areas of desirable soils having less steep slopes. The use of fertilizer to improve forage yields is questionable because of the difficulty and expense of applying the material on the ground. Most of this soil lies in parts of the foothills that are not easily accessible and consitutes an important part of local watersheds. The soil also provides extensive habitats for both large and small wildlife. Capability unit VIIe-1 (18); range site 2; natural land type E11; Storie index rating 19.

Auberry coarse sandy loam, 45 to 70 percent slopes (AuF).—This very steep soil occupies ridges and nonrocky canyon slopes. The profile of this soil is similar to that described as typical for the series, but it lacks the surface rockiness. The soil is surprisingly deep in places southeast of Miramonte. The cover density of woody vegetation generally ranges from about 40 to 80 percent, but in places it is more than 80 percent. On the other hand, some south-facing slopes are very open and clear of woody vegetation.

The general drainage is somewhat excessive. Runoff is very rapid, and the hazard of erosion is very high in unprotected areas.

This soil is used for grazing and browse for livestock. It also constitutes an important segment of local watersheds and provides refuge areas for wildlife. The steepness of the slopes reduces the amount of grazing by livestock, particularly late in the spring and during the dry-feed period of summer and fall. Planned location of stock trails and salt blocks can increase the utilization of the available forage. Forage production is fair to good in areas not covered by brush. Strip clearing in conjunction with development of stock trails through brushy areas of this soil can improve the browse value of the areas for both livestock and deer. Fertilization is not practical. Capability unit VIIe-1 (18); range site 2; natural land type E11; Storie index rating 10.

Auberry very rocky coarse sandy loam, 30 to 45 percent slopes (AvE).—This steep soil is on rocky hills, ridges, and canyon slopes. Rocks occupy about 10 to 25 percent of the surface area. The woody vegetation is mainly oaks and chaparral-forming shrubs; these woody plants cover 30 to 80 percent of the soil surface.

The general drainage is somewhat excessive, runoff is rapid, and the hazard of erosion is high. Surface rockiness has a local, variable effect on runoff and on erosion hazard. Some outcrops retard runoff and reduce the hazard of erosion. Other outcrops, particularly large, low-lying sheets of rock, may have an opposite effect.

This soil is important for livestock grazing, watersheds, and wildlife. The rock outcrops tend to reduce the forage production slightly but provide additional refuge sites for wildlife. The steepness of the slopes and their rocky surfaces preclude fertilizing the forage grasses on this soil. Capability unit VIIs-8 (18); range site 2; natural land type E12; Storie index rating 12.

Auberry very rocky coarse sandy loam, 45 to 70 percent slopes (AvF).—Surface rockiness on this soil ranges from about 2 to 50 percent. The depth of soil to weathered parent rock ranges from about 30 to 40 inches. This very steep soil is on rocky canyon slopes along the San Joaquin River and in the vicinities of Lefever Creek, White Deer Creek, Sand Creek, and the communities of Miramonte and Dunlap.

General drainage is somewhat excessive, runoff is very rapid, and the hazard of erosion is very high if the surface is left unprotected. Except where the vegetation has been recently burned, the woody cover of oaks and brush, as well as some Digger pine north of the Kings River, commonly occupies more than 50 percent of the surface area of the soil.

This soil is used for range and is an important part of local watersheds. It is also important in serving as a refuge area for wildlife. The rockiness and woody cover reduce the amount of forage produced, and the steep slopes hinder use by livestock. Stock trails, planned location of salt licks, and suitable placement of drift fences can increase the utilization of the avail-

able forage. Fertilization of the unit is not practical. Capability unit VIIs-8 (18); range site 2; natural land type E12; Storie index rating 6.

Auberry very rocky coarse sandy loam, shallow, 30 to 70 percent slopes (AwF).—The profile of this soil is shallower and has a thinner subsoil than that described as typical for the series. Rock outcrops occupy from 2 to 50 percent of the surface area. Depth to weathered parent rock averages about 20 inches, but in some places it is as much as 30 inches and in others as little as 15 inches.

This steep to very steep soil occupies rocky to extremely rocky hills, ridges, and canyon slopes in the general vicinity of Dunlap and Miramonte south of the Kings River. It is also near Tollhouse and Auberry and along the San Joaquin River. Woody vegetation is semidense on northern slopes, but semiopen to open on southern slopes.

The general drainage is somewhat excessive. Runoff is rapid, and erosion hazard is high or very high in unprotected areas. The available water holding capacity is low, reflecting the shallowness of the soil.

This soil is used for extensively grazed range, for watersheds, and as refuge areas by wildlife. The soil produces less forage than the less sloping soils, the season for green feed is shorter; and the soil dries earlier in the year. Some stock trails and suitable placement of salt licks may improve the utilization of the soil by livestock. Capability unit VIIs-8 (18); range site 2; natural land type E16, Storie index rating 6.

Auberry-Sierra coarse sandy loams, 15 to 30 percent slopes (AxD).—This complex consists of small areas of Auberry and Sierra coarse sandy loams so intricately intermingled that it is not practical to separate them at the scale used in mapping. Each of the two kinds of soil named makes up at least 20 percent of any given area, but the actual proportion is variable from place to place. The areas of this complex are on broad, branching crests of ridges and hilly areas near Miramonte and Pinehurst.

The profile of the Auberry soil is similar to that described as typical for the series but is uniformly deeper to weathered rock. The depth to weathered rock ranges from 4 to 6 feet. The profile of the Sierra soil is similar to that described under the Sierra series, but it is somewhat coarser textured in the surface layer.

Runoff is medium to rapid. The hazard of erosion is moderate to high. This complex is used mainly for range or for browse. The natural vegetation consists of dense chaparral and oak trees. Some areas have been cleared of brush and a cover of annual grass has been established. Forage crops respond to applications of fertilizer, and surface application is practical on these soils. Periodic burning or spraying is needed to control brush. The natural cover affords good protection for small wildlife. Some areas of these soils are used for country homesites, and some areas for apple orchards. The depth of the soils, their slope, and the climatic zone in which the soils formed indicate that areas of this complex are suitable for Christmas tree farms. Brush control is important to reduce the hazard of fire near sites used for homes and tree farms. Capability unit VIe-1 (17, 18); range site 2; natural land type E3; Storie index rating 48.

Auberry-Sierra coarse sandy loams, 30 to 45 percent slopes (AxE).—This complex consists of areas of Auberry and Sierra soils so intermingled that it is not practical to separate them at the scale used in mapping. The proportion is variable from place to place, but each of the two kinds of soil makes up at least 20 percent of any given area.

The profiles of these soils are similar to those described as typical for the respective series, but the Auberry soil in this mapping unit is uniformly deeper to weathered rock and the Sierra soil is somewhat coarser textured in the surface layer.

The general drainage of this complex is somewhat excessive, runoff is rapid, and the erosion hazard is high. The natural cover is similar to that of Auberry-Sierra coarse sandy loams, 15 to 30 percent slopes, but some southern slopes are less densely overgrown.

The areas of this complex are on steep canyon slopes and ridges in the vicinity of Miramonte and Pinehurst.

Included with this complex in mapping was a small area of similar soils northeast of Dunlap. The included soils differ in that depth to weathered parent rock is less than 48 inches.

These soils are used for rangeland where they are cleared of brush. Generally, brush clearance is limited to the ridgetops and gentle slopes. Area of this complex comprise important parts of local small watersheds and provide sites for wildlife refuge. Capability unit VIIe-1 (18), range site 2, natural land type E11; Storie index rating 26.

Auberry-Sierra coarse sandy loams, 45 to 70 percent slopes (AxF).—This complex consists of areas of Auberry and Sierra soils so intermingled that it is not practical to separate them at the scale used in mapping. The proportion is variable from place to place, but each of the two kinds of soil named makes up at least 20 percent of any given area. These very steep soils occupy nonrocky ridges and canyon slopes.

The profiles of these soils are similar to those described as typical for the respective series, but the Auberry soil is uniformly deeper to weathered rock and the Sierra soil is somewhat coarser textured in the surface layer.

The general drainage is somewhat excessive, runoff is very rapid, and the erosion hazard is high or very high. Although burned over by wildfire in the summer of 1956, these soils were subjected to little erosion during the following winter. If early rains are light, seeded grasses can be germinated on burned land and will grow sufficiently to hold the surface soil against washing from later rains.

The soils in this complex are used for range, watersheds, and wildlife areas. Their management is similar to that for Auberry coarse sandy loam, 45 to 70 percent slopes. Capability unit VIIe-1 (18); range site 2; natural land type E11; Storie index rating 13.

Auberry-Sierra very rocky coarse sandy loams, 45 to 70 percent slopes (AyF).—This complex is similar to Auberry-Sierra coarse sandy loams, 45 to 70 per-

cent slopes, but from 2 to 25 percent of the surface area of the soils is studded with irregularly shaped outcrops of parent rock. Depth to weathered parent rock is about 2 to 4 feet. Each soil makes up at least 20 percent of each area, but the proportions vary from place to place. Areas of this complex are in Mill Creek Canyon near Miramonte and Pinehurst and on slopes flanking Stony Flat.

The soils are used for range and browse, watersheds, and wildlife. Capability unit VIIs-8 (18); range site 2; natural land type E12; Storie index rating 6.

Auberry-Tollhouse Rock land complex, 30 to 70 percent slopes (AzF).—Auberry and Tollhouse soils are so intermixed with Granitic rock land that it is not practical to separate them at the scale used in mapping. Each soil and the rock land make up at least 20 percent of the complex, but the proportions vary from place to place.

The surface layer of both soils generally is coarse sandy loam. In places the Tollhouse soil is loamy coarse sand. Both soils are studded with rock outcrops, but the Auberry soil is normally less rocky. Otherwise, the profiles resemble those described as typical for their respective series. The Auberry soil in this unit supports a somewhat denser shrub-hardwood cover than normal for soils of the Auberry series, because it occurs with the Tollhouse soil, which has a typically dense shrubby cover. Granitic rock land consists of areas in each delineation of the complex that are one-half acre or more in extent and have more than 50 percent of the surface covered by granitic rock.

This complex is located, in part, on the canyon slopes of deeply incised streamways draining south of Miramonte into Tulare County. Other areas are on ridge slopes above Burrough Valley and the valley occupied by Cold Spring Rancheria. The largest areas of this unit are on the flanks of Black Mountain south of Auberry.

The soils of this complex are used for browse, watersheds, and wildlife. Capability unit VIIs-8 (18); range site 10; natural land type E12; Storie index rating 6.

Basic igneous rock land (BaF) is made up of areas that are 50 to 90 percent outcrops of basalt or metamorphic volcanic rock, mainly hornblende schist. In some areas more than 90 percent of the surface is basaltic rock. These are the columnar jointed cliffs adjacent to the remnants of old volcanic flows on top of Table Mountain and Squaw Leap.

Basic igneous rock land is widely distributed in both large and small areas throughout much of the foothills. The areas of basaltic rock are associated with old volcanic flows along the San Joaquin River and on Stony Flat north of Pinehurst. Those areas of rock-land consisting of hornblende schist are located mainly on Owens Mountain, on Bald Mountain, and on the drainageways of White Deer and Mill Creek north of Squaw Valley.

Most areas of Basic igneous rock land are steep to extremely steep, but some areas on hilltops or mesas have more gentle relief. The surface of these areas is generally very rough and broken and is stony as well as rocky. The outcrops are dull or dark in color and irregular in shape.

In most places the soil material between the outcrops is loamy and similar to adjacent soils that were formed from the same rock. Commonly, the depth of soil material is extremely variable within short distances. The natural vegetation is mainly annual grasses and forbs with some shrubs and hardwood trees, including interior live oak and canyon live oak. On north slopes and at higher elevations in the foothills, the cover of woody vegetation increases.

Except for some areas on rock faces, the general drainage is good to somewhat excessive. Runoff is variable; it is rapid in some local areas. However, over most of the areas of this land, surface water can drain into the many vertical cracks in the rocks or be trapped and absorbed by the soil material between the outcrops, where it is released more slowly.

Basic igneous rock land is used mainly as watersheds and as habitats for wildlife. However, some browsing or grazing is possible in less steep areas. Capability unit VIIIs-8 (18); range site not assigned; natural land type E17; Storie index rating 5.

Blasingame Series

The Blasingame series consists of well-drained to somewhat excessively drained, reddish-colored soils of the uplands that have a thick, well developed, moderately fine textured subsoil. These soils formed on weathered intrusive and metamorphosed basic igneous rocks. They are normally moderately deep or deep to the weathered rock. The surface relief ranges from undulating areas to very steep ridges and hills. Rockiness is associated with these soils on some of the steeper slopes. The natural vegetation is normally annual grasses and forbs under open stands of blue oak. However, there is no oak at lower elevations, and some brush invades areas of the soils at higher elevations.

The largest acreage of these soils is in the lower foothills north of the Kings River, at elevations of 400 to 2,000 feet. Some areas are located at somewhat higher elevations on southern exposures of salient ridges or hills. Average annual rainfall ranges from 14 to 22 inches, average annual temperature from 62° to 57° F., and average growing season from 225 to 250 days.

In a typical profile, the surface layer is reddish-brown and brown, slightly acid loam, about 6 inches thick, that is hard when dry. It overlies a fairly dense, thick subsoil, mainly of reddish-brown clay loam and sandy clay loam, that is neutral in most places and grades into strongly weathered gabbro-diorite or hornblende schist. The subsoil is about 26 inches thick.

Blasingame soils are well suited to grazing and nearly everywhere are used for this purpose. Small, undulating to rolling, rock-free areas are used for production of grain for hay. All areas of these soils are parts of small watersheds. Water for livestock and for domestic use is supplied by intermittently flowing streams, some springs, and a few shallow, low-volume wells. These wells are generally located in pockets of alluvium along small streams. Small dams are built in many places to conserve water for livestock on the intermittent streams.

Representative profile on a south-facing slope of about 17 percent, at an elevation of about 975 feet, in a hilly area used for range under vegetation of annual grasses and forbs with evidence of slight sheet erosion that is now stabilized (4½ miles, airline, NNW of Academy in SE¼SW¼NE¼ sec. 27, T. 11 S., R. 22 E.).

A1—0 to 1 inch, brown (7.5YR 5/4) loam, very dark brown (7.5YR 2/2) when moist; massive, breaking to platy fragments; hard when dry, friable when moist, slightly sticky when wet; plentiful fine and very fine roots; common very fine tubular pores; slightly acid (pH 6.2); abrupt, wavy lower boundary.

A3—1 to 6 inches, reddish-brown (5YR 4/3) loam, dark reddish brown (5YR 3/2) when moist; massive, breaking to coarse platy or fine, subangular blocky fragments; hard when dry, friable when moist, slightly sticky when wet; plentiful fine and very fine roots; common, fine and very fine, vertical tubular pores; slightly acid (pH 6.5); clear, wavy lower boundary.

B1t—6 to 10 inches, reddish-brown (5YR 4/3) sandy clay loam, dark reddish brown (5YR 3/2) when moist; weak, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; similar root and pore character and distribution as in A3 horizon; few thin clay films on ped faces and in pores; neutral (pH 7.0); abrupt, wavy lower boundary.

B21t—10 to 28 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/3) when moist; strong, very coarse, angular blocky structure; very hard when dry, firm when moist, slightly sticky and plastic when wet; few fine roots; few to very few fine tubular pores; moderately thick continuous clay films on ped faces; neutral (pH 7.0); gradual, wavy lower boundary.

B22t—28 to 32 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, very coarse, angular blocky structure; very hard when dry, firm when moist, slightly sticky and plastic when wet; few to very few very fine tubular pores; many thin to moderately thick clay films on ped faces; mildly alkaline (pH 7.5); abrupt, wavy lower boundary.

C—32 inches +, variegated black, dark-brown, reddish-yellow, and red weathered medium to coarse grained gabbro diorite; rock fabric clearly visible but hand samples crush fairly easily into a sandy mass; grades into unweathered rock within several feet; occasional tongues of material from B22t horizon penetrate this horizon for several inches, and clay films coat some minor joint faces.

The surface of the soil described in the foregoing profile is covered with a thin discontinuous litter of material from dried grasses and forbs. The color of the A horizon is commonly brown or reddish brown (7.5YR 5/4, 4/4; 5YR 4/4). Moist colors are typically reddish but range from dark brown to dark reddish brown (7.5YR 3/2; 5YR 3/2). The A horizon is normally massive but in places develops a weak, coarse, platy character from trampling. Trampling also increases the bulk density of the A horizon and reduces the water intake rate. Reaction of the A horizon is neutral or slightly acid. Texture of this horizon ranges from loam to clay loam. The thickness of the A horizon ranges from about 3 to 12 inches; the thinner areas reflect spotty effects of sheet erosion in the past.

The B horizon is thick in most places; its thickness ranges from about 18 to 40 inches. The thicker areas generally occur near the toe slopes of hills or ridges. Color of the B horizon is normally reddish brown when dry (5YR 4/4, 4/3), but in places it is dark reddish brown (5YR 3/4). Moist color is dark reddish brown (5YR 3/3, 3/4, 2.5YR 4/4). The texture of the B horizon does not vary much; it is clay loam or sandy clay loam. The reaction ranges from neutral to mildly alkaline. The B horizon is generally blocky when dry but appears massive when wet.

The depth of soil to the C horizon, or weathered rock, ranges mainly from about 24 to 48 inches. Some areas are as shallow as 16 inches; others are as deep as 60 inches.

Blasingame loam, 30 to 45 percent slopes (BcE).—A profile of this soil is described as typical for the Blasingame series. The color of the surface layer is commonly brown or reddish brown, but in places it is dark brown or yellowish brown. The depth of soil to weathered parent rock ranges mainly from about 20 to 40 inches.

This soil is somewhat excessively drained. Runoff is rapid. The erosion hazard is high on unprotected slopes. Many small drainageways show overdeepening of their channels, and some are actively cutting headward in the upper parts of their watersheds. The available water holding capacity is moderate to high. Permeability is slow.

This steep soil occupies ridges and hills between Owens Mountain and Watts Valley and is also in areas of Holland Creek east of Round Mountain. Some areas of this soil are located in the vicinities of Pine Flat Dam, Tivy Mountain, and Squaw Valley.

Included with this soil in mapping were small areas of similar soils that have a fine sandy loam or clay loam surface layer. These inclusions are widely distributed, mainly north of the Kings River. There are few or no rock outcrops. Narrow, small areas of Honcut and Los Robles soils are also included.

This soil is used for grazing and is one of the best forage-producing soils in the lower foothills. This is largely because of its favorable moisture-holding capacity. Reduced rates of water intake and increased runoff from the effects of trampling by livestock can reduce forage production that is dependent on available moisture in the soil. Fertilization is practical for this soil. Nitrogen can be expected to increase forage production materially in years when rainfall is near normal or above. The effects of phosphorus or sulfur are uncertain. Capability unit VIe–8 (18); range site 4; natural land type E9, Storie index rating 24.

Blasingame clay loam, shallow, 9 to 30 percent slopes (BlD).—The profile of this soil generally has a finer textured surface layer and a thinner solum than that described as typical for the series. The solum ranges from 18 to 24 inches in thickness. This soil ranges from rolling to hilly and is well drained. The hazard of erosion is moderate to high. Although the weathered rock beneath the soil is somewhat permeable, roots do not readily penetrate it. As a consequence, the available water holding capacity for this soil is significantly less than for the deeper soils of the Blasingame series. This soil dries out more quickly during extended periods of drought, and therefore is less productive under these conditions.

This soil is in the vicinity of Owens Mountain, northeast of Round Mountain, along the lower parts of Hughes Creek, and west of Bear Mountain. About one-third of the acreage consists of included small areas of a very similar soil with a loam surface layer.

The main use of Blasingame clay loam, shallow, 9

to 30 percent slopes is either range or pasture. During years of average rainfall forage growth is fair to good Fertilization for better growth of forage plants is practical Capability unit IVe-4 (18); range site 5; natural land type E5, Storie index rating 27

Blasingame clay loam, shallow, 30 to 45 percent slopes (BlE).—The profile of this soil has a finer textured surface layer and a thinner solum than the profile described as typical for the series. The solum is 18 to 24 inches thick. This steep soil occupies ridges and hills east of Owens Mountain, west of Humphreys Station, and south of Pine Flat Dam. The general drainage of the soil is somewhat excessive. Runoff is rapid, available water capacity is low, and erosion hazard is high.

This soil is used only for grazing. Its steeper slopes discourage intensive management for pasture Fertilization with nitrogen to increase forage yield is questionable. However, with well-distributed normal or above seasonal rainfall, growth of forage plants is increased. Capability unit VIIe-4 (18); range site 5; natural land type E13; Storie index rating 13.

Blasingame loam, 3 to 15 percent slopes (BcC).—This undulating to rolling soil has a profile like the one described as representative of the series. It is widely distributed along the lower margin of the foothills from the vicinity of Friant to Squaw Valley. It is well drained. Runoff is slow or medium, and the erosion hazard is moderate. Some areas are open grasslands; others have an open to semiopen cover of blue oak in association with the annual grasses and forbs.

Included with this soil in mapping were areas having a surface layer of fine sandy loam and light clay loam.

Blasingame loam, 3 to 15 percent slopes, is used mainly for range or dryland pasture. Some areas are used to grow dryfarmed barley or hay With adequate moisture, the forage on this soil will respond very well to nitrogen fertilizer Where they are readily accessible, areas of this soil are well suited to dryland pasture and its more intensive management. When the soil is dryfarmed, care should be used in cultivating to minimize erosion losses Capability unit IIIe-8 (18); range site 4; natural land type E1; Storie index rating 51.

Blasingame loam, 15 to 30 percent slopes (BcD).—This hilly soil occupies numerous areas, mainly in the lower foothills north of the Kings River. Small areas included in mapping have a fine sandy loam surface layer. The soil is well drained, runoff is medium to rapid, and the hazard of erosion is moderate to high.

This soil is best suited to grazing; this is its only use. Some areas are suitable for dry pasture in conjunction with other soils on less steep slopes. Range fertilization is practical and increases growth of forage plants in years of adequate rainfall. Capability unit IVe-8 (18); range site 4, natural land type E1; Storie index rating 45

Blasingame loam, 45 to 70 percent slopes (BcF).—The profile of this soil is similar to the one described as typical for the series. This very steep soil occupies prominent ridges and hills in both the lower and the upper foothills. In the upper foothills it is located on southerly or westerly aspects of salient ridges or mountains. Areas of this soil are located near Watts Valley, Black Mountain, and Pine Flat Dam, as well as near Dunlap and the lower Sand Creek drainage. Drainage is somewhat excessive, runoff is rapid, and the hazard of erosion is high or very high.

Included with this soil in mapping were many small areas of Tretten, Trimmer, and Trabuco soils in protected swales or ravines. Between Watts Valley and the headwaters of Fancher Creek and other small creeks, the areas of this soil tend to grade toward the Trimmer soils. Small areas of such soils as Delpiedra, Fancher, and Vista have also been included, generally where they are adjacent to large areas of this mapping unit. Some surface stoniness or rockiness occurs in places

This soil is used only for grazing. The steepness of the slopes tends to reduce the grazing intensity by livestock. Construction of stock trails and planned location of salt licks can improve the distribution of cattle on areas of this soil and bring about better use of the good forage that is available Range fertilization is not practical. Some of the larger areas of this soil comprise significant parts of small watersheds. Capability unit VIIe-1 (18); range site 4; natural land type E9; Storie index rating 12.

Blasingame loam, shallow, 45 to 70 percent slopes (BdF).—This very steep soil is mainly on south facing slopes of prominent hills or ridges. Its profile is similar to that described as typical for the series, but the subsoil is much thinner. Depth of soil overlying the weathered parent rock ranges from about 16 to 24 inches. The available water holding capacity is low. Drainage is somewhat excessive, runoff is rapid, and the hazard of erosion is high

This soil is on Hughes Mountain, near Owens Mountain, Humphreys Station, Clark Valley, and lower Mill Creek Valley.

Included with this soil in mapping were areas in which there has been slight sheet erosion and some steep areas where there is overdeepening of some parallel natural drains. Cobblestones are on the surface of some of the eroded areas.

This soil is used only for grazing. It is suitable only for grazing because of the steep slopes and the poor growth of forage plants, which is governed by the relatively low water-holding capacity of the soil. Because of the low water-holding capacity, the soil dries out earlier in the spring than most similar soils. Development of stock trails and suitable placement of salt licks help to gain better use of the forage available Range fertilization is not practical. Capability unit VIIe-4 (18); range site 5; natural land type E13; Storie index rating 8.

Blasingame very rocky clay loam, 30 to 45 percent slopes (BmE).—This soil is similar to Blasingame loam, 30 to 45 percent slopes, but has a clay loam surface layer and many large outcrops of parent rock. The outcrops are gray or dark gray from lichen coatings. They have angular to subangular blocky shapes, stand 2 to 4 feet in height, and measure from about 2 to 5 feet across. From about 10 to 25 percent of the surface area of each area of soil is occupied by these

outcrops. In addition, some angular stones and cobblestones are scattered over the surface or are imbedded within the soil material. Runoff is medium, and the erosion hazard is high. Drainage is somewhat excessive to rapid. Runoff and erosion are somewhat affected by the patterns of rock outcrops.

Most of this soil is located near the headwaters of Holland Creek. Some smaller areas lie near Humphreys Station, and on Tivy and Jesse Morrow Mountains.

Almost one-third of the acreage of this unit consists of included similar soils that have a surface layer of loam or fine sandy loam.

This soil is used for grazing. It comprises important parts of some small watersheds, and the outcrops provide minor refuge sites for small wildlife. The use of this unit for forage production, in relation to Blasingame loam, 30 to 45 percent slopes, is diminished somewhat in proportion to the area occupied by rock outcrops. Range fertilization is effective but less profitable on this soil. Capability unit VIs–81 (18); range site 4; natural land type E12; Storie index rating 14.

Blasingame very rocky loam, 2 to 30 percent slopes (BgD)—Surface rockiness ranges from 2 to 25 percent, but otherwise the profile of this soil is similar to that described as typical for the series. The soil is undulating to hilly and is impractical to cultivate because of the rockiness.

This soil is widely distributed in the lower foothills. It is well drained. Runoff is medium, and the erosion hazard is moderate to high.

This soil is used only for grazing, for which it is well suited. Fertilization of the range with nitrogen is practical, and very good response of forage growth is obtained if the seasonal rainfall is adequate. The outcrops provide some temporary protection, nesting, or den sites for small wildlife. Capability unit VIs 8 (18); range site 4; natural land type E4; Storie index rating 34.

Blasingame very rocky loam, 45 to 70 percent slopes (BgF)—This soil is similar to Blasingame loam, 30 to 45 percent slopes, but has a rocky surface and is steeper. About 10 to 50 percent of the surface area of this soil is covered by rock, but there are many areas that are less than 25 percent.

This rocky, very steep soil occupies prominent ridges and hills in the lower and middle foothills. At higher elevations it is on west- or south-facing slopes. Drainage is somewhat excessive. Runoff is rapid, and the hazard of erosion is high or very high.

Included with the soil in mapping were some areas, in the vicinity of Owens and Wildcat Mountains, of similar soils that have a surface layer of fine sandy loam or clay loam.

This soil is used extensively for grazing. It is an important part of the headwater areas of some small watersheds. The rocky areas provide refuge sites for small wildlife. The depth of soil provides a moderate available water holding capacity, and forage growth is good with adequate rainfall. The steepness of the slopes, however, reduces the intensity of grazing by cattle. Development of stock trails and planned location of salt licks can gain better livestock distribution. Because of the reduced intensity of use and difficulties of surface application, fertilization is not practical. Capability unit VIIs–8 (18); range site 4; natural land type E12; Storie index rating 8.

Blasingame extremely rocky loam, shallow, 30 to 70 percent slopes (BkF)—This shallow, rocky soil varies widely in slope. Soil depth to weathered parent rock ranges from about 16 to 24 inches. Much of it is 20 inches or less; otherwise the profile is similar to that described as representative of the series. Rock outcrops comprise from 10 to 50 percent of the surface area of this soil. The more rocky areas are generally on the steeper slopes. This soil occupies southerly or westerly slopes of steep to very steep ridges and hills in the lower foothills.

Drainage is somewhat excessive. Runoff from this soil is generally rapid, but is somewhat variable locally, depending upon the location and shape of the outcrops. The soil is relatively droughty in relation to the deeper soils in the Blasingame series. The hazard of erosion is high or very high.

This soil is used for grazing. The low water-holding capacity limits growth of forage plants, particularly in years that are drier than normal. In addition, the soil tends to dry out early in spring. The rock outcrops materially reduce forage production and the intensity of grazing by cattle is less on the steeper slopes. The development of stock trails may open some areas to more intensive use. Range fertilization is not practical. Areas of this unit have importance in small watersheds and provide many refuge sites among the rocks for small wildlife. Capability unit VIIs 8 (18); range site 10; natural land type E15; Storie index rating 8.

Borden Series

The Borden series consists of deep, well drained to moderately well drained, brown or brownish soils that have a compact, moderately fine textured subsoil. These soils formed in the granitic alluvium of older fans. The soils of this series have a smooth surface, are nearly level, and are saline-alkaline in places.

These soils are mainly in positions that were moderately well drained under natural conditions. Most of their acreage is on the older fans of Fancher and Dry Creeks southwest of the city of Fresno, at elevations of 200 to 300 feet. A few small areas are located in the lower valleys of the foothills at elevations of about 1,000 feet. The average annual precipitation ranges from about 8 to 10 inches at the lower elevations and is about 15 inches in the valleys of the foothills. The average annual temperature is about 62° F. The growing season ranges from about 225 to 250 days.

A representative profile of the Borden series has a surface layer about 7 inches thick. This layer is brown loam in the upper part and dark-brown heavy sandy loam in the lower part. It overlies a dark-brown to dark reddish-brown subsoil of compact, moderately alkaline sandy clay loam that is calcareous in many places. The subsoil is about 31 inches thick. Beneath the subsoil is a layer of brown sandy loam that extends to a depth of 60 inches.

These soils are used extensively for crops. Most areas are used for field crops, vineyards, and in some places for fruit trees. Irrigation water is obtained from deep wells by pumping and from irrigation district canals. In the lower foothills these soils are used for range or dry pasture. Their small acreage and their location prohibit intensive crop management.

Representative profile in a nearly level, fallow field at an elevation of about 260 feet (SW. of Fresno; ¼ mile SW. of the intersection of Church and Brawley Avenues in the SW¼NE¼SE¼ sec. 14, T. 14 S., R. 19 E.):

Ap1—0 to 4 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; moderate, fine to medium granular structure; slightly hard to hard when dry, friable when moist, sticky and slightly plastic when wet; neutral (pH 7.3); abrupt, wavy lower boundary.

Ap2—4 to 7 inches, dark-brown (10YR 4/3) heavy sandy loam near loam, dark brown (10YR 3/3) when moist; massive, breaking to coarse subangular fragments; hard when dry, friable when moist, sticky and slightly plastic when wet; common fine and very fine tubular pores; neutral (pH 7.1); abrupt, smooth lower boundary.

B1t—7 to 12 inches, dark-brown (10YR 4/3) sandy clay loam near loam, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure breaking to moderate, coarse, angular blocky structure; extremely hard when dry, very firm when moist, sticky and plastic when wet; many thin clay films on ped faces; common fine and very fine tubular pores; neutral (pH 7.0); abrupt, irregular lower boundary.

B2t—12 to 30 inches, dark reddish-brown (5YR 3/3) sandy clay loam, very dark reddish brown (5YR 2/3) when moist; weak, coarse, prismatic structure breaking to medium, coarse, angular blocky structure; extremely hard when dry, very firm when moist, sticky and plastic when wet; thin, and some thick, continuous clay films on ped faces; few fine and very fine tubular pores; mildly alkaline (pH 7.8); abrupt, irregular lower boundary.

B3ca—30 to 38 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; medium, coarse, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; lime segregated in a network of fine to medium filaments; common thin clay films on ped faces; very few fine and very fine tubular pores; many microsize interstitial pores; moderately alkaline (pH 7.9); clear, irregular lower boundary.

C—38 to 60 inches, brown (10YR 5/3) heavy sandy loam, dark brown (10YR 4/3) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many microsize interstitial pores; intermittently calcareous; moderately alkaline (pH 8.1).

The color of the A horizon is generally brown but is grayish brown in places. The hue is 10YR, the values are 4 or 5, and the chroma is 3 or, in some places, 2. Moist colors are brown or dark brown to dark grayish brown; the hue is unchanged, but the value drops to 3 or 4 and the chroma is 2 or 3. Undisturbed sites have a massive A horizon that is hard when dry. In tilled areas this horizon generally has a pseudostructure, which appears to be subangular blocky or granular. The A horizon ranges from loam to clay loam and from neutral to mildly alkaline.

The dry color of the Bt horizon ranges from brown to dark reddish brown. The hue is 10YR, 7.5YR, or 5YR, the value is 3 to 5, and the chroma is 3 to 4. Moist colors range from dark brown to very dark reddish brown. The hue and chroma are similar to those of the dry color, but the value is 2 or 3. The Bt horizon is sandy clay loam or clay loam. Structure ordinarily is moderate to strong, medium or coarse, angular blocky, but a weak, coarse, prismatic structure is visible in places. The profile is neutral or moderately alkaline and variably calcareous. In some places the lime is disseminated, but in most places it is in nodules or filaments.

The C horizon is similar to the A horizon in color. It ranges from sandy loam to clay loam in texture, has no structure, and is variably calcareous. In places it lies unconformably on compact silty material. Where the soil is saline-alkali affected, the A, B, and C horizons are strongly alkaline.

Borden loam (0 to 2 percent slopes) (Bn).—This soil has a profile described as typical for the series. It is nearly level or very gently undulating. Except for the inclusions in the slightly depressed positions, this soil is now well drained. Runoff is slow; permeability is moderately slow; and there is no erosion hazard. The available water holding capacity is high. This soil is mainly in the vicinity of Kearney Park and the city of Fresno.

Included with this soil in mapping were small areas of similar soils in a few small valleys in the lower foothills. In some of these areas the surface layer is sandy loam or fine sandy loam. Other included soils are located near Kearney Park. These consist of small areas of similar soils that have a clay loam surface layer that is slightly darker colored. They occupy very slight depressional positions and are moderately well drained.

Nearly all the acreage of this soil is now under cultivation, the surface has been smoothed and leveled. All areas of this soil except those in the lower foothill valleys are irrigated and intensively cropped. Under proper management field crops such as alfalfa, cotton, corn, and grain sorghum are well suited. Nitrogen and phosphorus fertilizers are needed. Care is required in applying water for irrigation because of the moderately slow permeability of the soil. Some grapes are grown. The soils are not well suited to peaches. Some plum orchards have been established. Unirrigated areas of this soil in the foothill valleys are used for range or pasture. Capability unit I-1 (17, 18); range site not assigned; natural land type A2; Storie index rating 81.

Borden loam, saline-alkali (0 to 2 percent slopes) (Bs).—Except that it is saline-alkali affected, the profile of this soil is similar to that described as typical for the series. This soil occupies very slight depressional areas in the older alluvium along Fancher Creek and Big Creek, southwest of Fresno.

The subsoil is generally strongly alkaline and at least slightly saline from excess amounts of soluble salts. Unless the soil is reclaimed, rooting activity in the subsoil is very restricted. In addition, almost half of the acreage has from about 5 to 33 percent of the surface layer similarly affected, and this results in poor growth, or no growth, of plants in the affected spots. Where these spots occur, they are rather evenly distributed throughout a given area of the soil. Intermingled with the affected spots, or in areas where only the subsoil is affected, are areas of the soil that are saline-alkali free.

Unless reclaimed, the soil produces only a fair growth of field crops, at best. It is not suitable for vineyards or fruit trees. Fair to good irrigated pasture has been developed in areas affected only in the subsoil. The soil can be reclaimed, but reclamation is time-consuming because of the moderately slow permeability of the subsoil. Irrigated barley, irrigated pasture, and alfalfa are crops that are grown during reclamation to partially offset the cost. Procedures used in reclamation are discussed in the section "Saline and Saline-Alkali Soils." Capability unit IIs-6 (17); range site not assigned; natural land type A2-2s; Storie index rating 49.

Borden loam, moderately deep (0 to 2 percent slopes) (Bl).—The profile of this soil is similar to that described as typical for the series, except that it is underlain by a thick, compact silty layer at a depth of 2 to 4 feet. The silty layer is not impermeable, but it retards deep root penetration and restricts internal drainage somewhat. Permeability is slow; the available water holding capacity ranges from low to high. The silt layer ranges from light gray to brown and is conspicuously mottled with bright colors.

This soil is southwest of Kearney Park in the general vicinity of the intersection of Dickenson Avenue and McMullin Grade.

A small area of a similar soil that has a sandy loam surface layer was included with this soil in mapping.

Borden loam, moderately deep, is used for field crops and is well suited to irrigated pasture. With careful irrigation, alfalfa, corn, cotton, and grain sorghum are suitable. Applications of irrigation water should be controlled to avoid development of a saturated zone above the compact substratum. To improve internal drainage, the shallower layers of the substratum can be shattered by ripping. Capability unit IIs 3 (17); range site not assigned; natural land type A2; Storie index rating 70.

Borden loam, moderately deep, saline-alkali (0 to 2 percent slopes) (Bo).—This soil has a thick, compact slowly permeable silty layer at a depth ranging from 2 to 4 feet. The soil has a profile similar to the one described as representative of the series except that it is saline-alkali. Unless the soil is reclaimed, rooting activity in the subsoil is very restricted. This soil is located southwest of Kearney Park.

Included with this soil in mapping were areas of a similar soil that has a surface layer of clay loam.

Unless it is reclaimed, this Borden soil is, at best, only fairly well suited to field crops, not suited to vineyards or trees, and fair for pasture. Unless the soil is deeply ripped, reclamation is slow and difficult because of the compact silty substratum. Reclaimed areas are well suited to irrigated pasture and are suited to such field crops as alfalfa, corn, cotton, and grain sorghum. However, the soil must be watched for possible return of saline-alkali conditions brought on by overirrigation or by a rise in the level of ground water. Capability unit IIIs-6 (17); range site not assigned; natural land type A2-2s; Storie index rating 42.

Cajon Series

In the Cajon series are deep, light-colored, coarse-textured soils that have a low or very low water-holding capacity. They are excessively drained, are open and very porous, and formed on recent sandy, granitic sediments on young alluvial fans. The natural surface relief is smooth and ranges from nearly level to gently undulating.

The Cajon soils occupy former flood distributary channels on the lower part of the river fans. These channels have aggraded with coarse alluvium to about the general level of the fan surface. They are winding and branching, with lesser branches narrowing and eventually disappearing. Some areas of these soils occupy slightly depressed parts of these channels; others occupy low stream ridges that are rounded in cross section and stand 1 to 3 feet above the flanking land surface. Many winding areas of these soils continue downslope to the basin lands, where they disappear. Others terminate on the young fans that spread out into irregularly shaped areas.

Leveling and development of these soils for farming destroy their surface features and leave streaks of coarse textured material, along with moderately coarse textured or medium-textured soil material. The native vegetation consists of a sparse growth of annual grasses, forbs, and some saline-alkali tolerant plants.

The Cajon soils are distributed from the general vicinity of Kerman and Kearney Park, west toward Whites Bridge, and south to the vicinity of Burrel and Caruthers. They are at elevations of 170 to 250 feet. The average annual precipitation is about 8 inches; the average annual temperature is about 62° F.; the average growing season ranges from 225 to 250 days.

In this area the Cajon soils are typically pale brown, mildly to moderately alkaline to very strongly alkaline, and coarse textured to a depth of more than 60 inches. Where saline-alkali affected, the soils are strongly to very strongly alkaline.

Cajon soils, under irrigation, are used mainly for field crops and irrigated pasture. Undeveloped areas in the basin rim zone that include these soils are grazed by beef cattle and by dry dairy stock.

Representative profile in a nearly level area of range pasture having a sparse cover of annual grasses and saline-alkali tolerant plants, at an elevation of about 190 feet (SW. of Kerman; 1 mile E., and ¾ mile S. of the intersection of Yuba and Jensen Avenues, near the W. quarter corner of SW¼ sec. 20, T. 14 S., R. 17 E.):

A1—0 to 1½ inches, pale-brown (10YR 6/3) loamy sand, dark yellowish brown (10YR 4/4) when moist; massive, breaking readily to single grain; soft to loose when dry, very friable when moist, nonsticky and nonplastic when wet; plentiful microsize roots, many microsize interstitial pores; slightly effervescent with disseminated lime; moderately alkaline (pH 8.4); abrupt, wavy lower boundary.

C1—1½ to 51 inches, pale-brown (10YR 6/3) loamy coarse sand, dark yellowish brown (10YR 4/4) when moist; massive, breaking readily to single grained; soft to loose when dry, very friable when moist, nonsticky and nonplastic when wet; few microsize roots extend to a depth of 28 inches, very few or

no roots below 28 inches; many very fine and microsize interstitial pores and few microsize tubular pores; strongly effervescent with disseminated lime; very strongly alkaline (pH 9.1); gradual, wavy lower boundary.

C2—31 to 63 inches +, pale-brown to very pale brown (10YR 6/3) loamy coarse sand, dark yellowish brown (10YR 4/4) when moist; single grain; loose when dry, very friable when moist, nonsticky and nonplastic when wet; many microsize and very fine interstitial pores; strongly effervescent with disseminated lime; very strongly alkaline (pH 9.1).

There are few (about 5 percent of volume) subrounded and rounded fine pebbles throughout the profile. Scattered on the surface are spots of an erosion pavement which consists of fine gravels and very coarse sand.

Color of the A horizon ranges from light gray to pale brown. In most places the hue is 10YR, the value is 6 or 7, and the chroma is 2 or 3. In some places the hue is 2.5Y and the value/chroma combinations are 6/2 or 7/2. Moist colors are limited to yellowish brown or dark yellowish brown. The hue is generally 10YR, the value 4 or 5, and the chroma has brightened to 4. The A horizon is massive or single grain. Consistence ranges from slightly hard to loose. Reaction of the A horizon ranges from mildly to strongly alkaline. The A horizon is loamy sand, loamy coarse sand, sandy loam, or coarse sandy loam. It ranges from about 1 to 20 inches in thickness. It has a low but appreciably greater content of organic matter than the underlying C horizon.

The color of the C horizon is similar to that of the A horizon. Texture ranges from loamy sand to coarse sand, and there is a tendency for the coarse-particle content to increase with depth. The C horizon is massive or single grain. Its dry consistence is slightly hard or loose. The reaction ranges from moderately to very strongly alkaline, the latter occurring in areas that are saline-alkali affected. In places the coarse C horizon overlies an unrelated, compact silty substratum at a depth of 3 to 4 feet.

The presence of disseminated lime is variable in the upper 12 inches of this soil, but below this depth the profile is at least very slightly calcareous, commonly strongly calcareous, and occasionally very strongly calcareous.

Cajon loamy coarse sand, saline-alkali (0 to 2 percent slopes) (Cb).—The profile of this soil is similar to that described as typical for the series. The texture of the surface layer is loamy coarse sand, but in small included areas it is loamy sand. The underlying material in many places consists of stratified sandy material that becomes coarser textured with depth.

The soil is saline-alkali or alkali affected mainly below the surface layer. The substratum is typically strongly to very strongly alkaline but may or may not contain an excessive accumulation of soluble salts. In some places the surface layer is partly affected.

Permeability is rapid, and runoff is very slow. The available water holding capacity is very low. Soil blowing is a slight hazard in unprotected areas.

Undeveloped areas of this soil are used for grazing in association with other somewhat finer textured soils. Because of the coarse texture and consequent low water-holding capacity, this soil produces sparse amounts of forage. The alkaline subsurface layer severely restricts root growth and further reduces plant growth and forage yield. Under irrigation the soils are readily reclaimed. Excess salts are easily flushed below the root zone. Gypsum added to the soil helps to lower the strongly alkaline reactions. After reclamation, the soil is commonly used to grow alfalfa or cotton, or for irrigated pasture. Nitrogen and phosphorus fertilizers, along with frequent irrigation, are necessary for a good growth of crops. Capability unit IIIs-4 (17); range site not assigned; natural land type A5-2s; Storie index rating 50.

Cajon coarse sandy loam (0 to 2 percent slopes) (Cc).—This soil has a coarse sandy loam surface layer and is free of saline-alkali or alkali conditions. Otherwise, the profile is similar to that described as typical for the series. The surface layer ranges from about 6 to 20 inches in thickness but is commonly 10 to 12 inches thick. Its texture varies somewhat from place to place, being either a sandy loam or a coarse sandy loam. The surface layer is slightly calcareous in places and is mildly to moderately alkaline. The profile below the surface layer typically consists of stratified, calcareous loamy coarse sand, loamy sand, and sand. The lime is generally disseminated, but in places it occurs in the form of fine threads. A few small pebbles of quartz and fragments of feldspar are scattered through the profile.

The general drainage is somewhat excessive. Although the available water holding capacity is very low, the soil can hold somewhat more water in its surface layer than Cajon loamy coarse sands.

This soil is located in the basin rim zone northeast of Tranquillity, northeast and east of San Joaquin, and north of Riverdale. Areas of the soil are long and winding, similar to those of Cajon loamy coarse sand, saline-alkali, but in many places they are much wider.

Included with this soil in mapping were some small areas of Hesperia sandy loam.

Undeveloped areas of Cajon coarse sandy loam are used for grazing. Forage growth is fair. Where the soil is leveled and irrigated, it is used for irrigated pasture and for alfalfa. The soil is fairly well suited to cotton, corn, and grain sorghum. If possible leveling operations should avoid stripping away the surface layer, which has a higher water-holding capacity than the coarser textured subsurface layer. Nitrogen and phosphorus fertilizers are required, as well as frequent irrigation. Capability unit IIIs-4 (17); range site not assigned; natural land type A5; Storie index rating 72.

Cajon coarse sandy loam, saline-alkali (0 to 2 percent slopes) (Cd).—This soil is saline-alkali or alkali affected, otherwise it is similar to Cajon coarse sandy loam. In most places the soil is free of excess salts and alkali to a depth ranging from about 10 to 30 inches. The affected parts of the underlying material are generally strongly alkaline or very strongly alkaline with generally at least a slight degree of salinity from an accumulation of salt.

Included with this soil in mapping were areas of similar soils that have from 5 to 33 percent of the surface layer similarly affected.

This soil is located entirely within the basin rim zone. Areas of this soil are located northeast of Tranquillity, northeast and east of San Joaquin, and northeast of Burrel. Most of them have a long, sinuous form, but a few broaden into irregular shapes.

If areas of this soil are reclaimed, the use and management are similar to that of Cajon coarse sandy loam.

Capability unit IIIs-4 (17); range site not assigned; natural land type A5-2s; Storie index rating 58.

Cajon coarse sandy loam, moderately deep, saline-alkali (0 to 2 percent slopes) (Ce).—This soil is similar to Cajon coarse sandy loam but overlies a compact, slowly permeable, intermittently calcareous and noncalcareous silty substratum. It is at a depth ranging from 3 to 4 feet. It is saline-alkali or alkali affected.

The internal drainage of the soil is slowed by the substratum. The substratum consists of layers of light-gray to white, compacted silt or silt loam that range in thickness from several inches to several feet. In many areas these layers are separated by layers of sandy material. The upper layer of the substratum has an irregular surface and is fractured in places. In most places the uppermost 10 inches of the soil is saline-alkali free. Below a depth of about 10 inches, it is strongly to very strongly alkaline and commonly is at least slightly saline. Many areas of this soil have from 5 to 33 percent of their surface layer similarly affected.

This soil is in the basin rim zone northeast of Burrel and east of San Joaquin.

Included with this soil in mapping were a few small areas that have a surface layer of loamy coarse sand or loamy sand. In addition, some included areas are free of saline-alkali or alkali conditions. These consist of small reclaimed areas or areas that were not affected in their natural state.

With reclamation, the use and management of the soil are similar to those of Cajon coarse sandy loam. Reclamation is not so rapid as for Cajon loamy coarse sand, saline-alkali, because of the slight restriction to internal drainage. However, reclaiming the soil is practical and can be speeded in some places by breaking up the substratum by deep ripping. Capability unit IIIs-4 (17); range site not assigned; natural land type A6-2s; Storie index rating 41.

Cajon loamy coarse sand (0 to 2 percent slopes) (Ca).—This soil is free of excess salts and alkali; otherwise, the profile is similar to that described as representative of the Cajon series. It is located on the lowerlying outer parts of the young fans along the San Joaquin River and the Kings River. Areas of the soil are mainly confined within the basin rim zone.

Unirrigated areas are used for grazing in association with other soils. The soil produces only sparse forage, which consists of annual grasses and forbs. Under irrigation, alfalfa, cotton, corn, and grain sorghum are fairly well suited. Frequent irrigation is required. Nitrogen and phosphorus fertilizers must be applied. After several years of cropping, cotton will respond to potassium fertilizer. Capability unit IIIs-4 (17); range site not assigned; natural land type A5; Storie index rating 63.

Calhi Series

The Calhi series consists of deep, somewhat excessively drained, weakly calcareous soils that formed in stabilized dunes of uniformly coarse-textured material. This material was laid down by wind that scoured sandy, granitic alluvium. Some of the characteristics of the soils indicate the presence of a shallow, fluctuating water table in the past. The surface relief is undulating to gently rolling. Areas of these soils are parallel to the northwesterly direction of the prevailing winds and stand several feet above the general level of the surrounding alluvial land.

The Calhi soils are within the basin rim zone, mainly on the lower parts of the young fan of the Kings River in the general vicinity of Caruthers and Raisin City. Some minor areas are located west of Kerman on the lower parts of the young fan of the San Joaquin River.

The soils are at elevations of 175 feet to 250 feet. Average annual precipitation is about 8 inches, average annual temperature is 62° F., and average annual growing season is 225 days. The natural vegetation is a sparse stand of annual grasses and forbs, saltgrass, and other plants that are saline-alkali tolerant or that are resistant to drought.

A typical profile has a light brownish-gray to gray or light gray, loose loamy sand surface layer that is moderately alkaline, noncalcareous, and is about 11 inches thick. The surface layer overlies a thick layer of light gray to pale yellow uniform loamy sand that is typically weakly calcareous and is strongly alkaline.

Without irrigation these soils are used for grazing or are idle. They produce only limited amounts of forage. With irrigation they are suited to many kinds of field crops.

Representative profile on a south-facing slope of 3 percent in an undulating, wind-modified area in range pasture, at an elevation of about 215 feet; vegetation is annual grasses, forbs, and saltgrass (2 miles, airline, NE. of Burrel in the NW¼NW¼NW¼ sec. 31, T. 16 S., R. 19 E.):

A11—0 to 2 inches, light brownish gray (10YR 6/2) loamy sand, dark grayish brown (10YR 4/2) when moist; single grained; loose when dry, nonsticky and nonplastic when wet; plentiful very fine roots; many very fine interstitial pores; mildly alkaline (pH 7.6); clear, wavy lower boundary.

A12—2 to 11 inches, gray to light gray (10YR 6/1) loamy sand, dark gray (10YR 4/1) when moist; single grained; loose when dry, nonsticky and nonplastic when wet; plentiful very fine roots; many very fine interstitial pores; slightly effervescent with disseminated lime; moderately alkaline (pH 8.4); abrupt, wavy lower boundary.

C1—11 to 31 inches, light gray (2.5Y 7/2) loamy sand, grayish brown (2.5Y 5/2) when moist; massive, breaking readily to single grained; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; very few fine roots; many very fine interstitial pores; slightly effervescent with disseminated lime; strongly alkaline (pH 8.6); gradual, wavy lower boundary.

C2—31 to 54 inches, pale yellow (2.5Y 7/4) loamy sand, light olive brown (2.5Y 5/4) when moist; few, fine, prominent, yellowish-red mottles; massive, breaking readily to single grain; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; few very fine roots; many very fine interstitial pores; noncalcareous; strongly alkaline (pH 8.7); gradual, wavy lower boundary.

C3—54 to 60 inches, pale-yellow (2.5Y 7/4) sand, light olive brown (2.5Y 5/4) when moist; common, medium, prominent, yellowish-red mottles; single

grain, loose when dry or moist; many very fine interstitial pores; strongly alkaline (pH 9.0).

The A horizon ranges from 2 to 12 inches in thickness. Its color ranges from pale brown or light brownish gray to light gray. The hue is 10YR or 2.5Y, the value is 6 or 7, and the chroma is 2, 3, or in some places, 4. Moist colors are similar in hue and chroma, but their value is generally 4 or 5. The A horizon is without structure, generally single grained, and has a dry or moist consistence that is typically loose. This horizon ranges from mildly to moderately alkaline and is normally noncalcareous.

The C horizon ranges from light gray to pale yellow in color. The hue is 10YR or 2.5Y, the value 6 or 7, and the chroma 2 to 4. The moist colors range from grayish brown to light olive brown. The hue is most commonly 2.5Y, with a value of 4 or 5, but with no change in the range of chroma. Mottles are intermittently present. The C horizon is massive or single grain. Dry consistence ranges from slightly hard to loose. The reaction ranges from moderately to strongly alkaline. The cation exchange capacity is very low, and the soils are generally very low in soluble salts, but the proportion of adsorbed sodium may be high. Disseminated lime is commonly present but varies widely within the substratum. In some places the C horizon has no detectable lime, and in other places it has lime in the form of fine, weakly developed filaments. In places an unrelated, compact silty layer lies at a depth ranging from 2½ to 5 feet or more.

Calhi loamy sand, 0 to 3 percent slopes (CfA).—This soil formed in low lying, undulating, wind laid deposits in the general vicinity of Raisin City, Caruthers, and Burrel. The profile of this soil is very similar to that described as representative of the series. In places, the soil overlies a compact silty substratum at a depth of 5 feet or more. If the soil is irrigated, the strongly alkaline reaction of the underlying material quickly lowers to a moderately alkaline or mildly alkaline level.

The general drainage is somewhat excessive. The local water table is deep and in large areas is lowered by general pumping for irrigation water. The soil is rapidly permeable, and runoff is very slow. The available water holding capacity is very low. If the surface is left unprotected, there is a slight to moderate hazard of soil blowing.

This soil is irrigated from deep-well pumps by use of sprinklers, or in some places it is leveled for surface irrigation. Alfalfa and cotton are grown under sprinkler irrigation. Leveled areas are used for corn, grain sorghum, and some irrigated pasture. Frequent applications of irrigation water are required. Nitrogen and phosphorus fertilizers are needed. Cotton responds to potassium fertilizers after several years of cropping. Some raisin grapes are grown on areas of this soil near the eastern limit of its extent. Unirrigated areas of this soil are used for dry pasture. Many doves congregate on unused areas of this soil where turkeymullein is well established. Capability unit IIIs-4 (17); range site not assigned; natural land type A5; Storie index rating 72.

Calhi loamy sand, 3 to 9 percent slopes (CfB).—This soil has a gently rolling, hummocky relief. It has a profile similar to that described as representative of the series. Many areas of this soil occupy long bladelike ridges that lie northwest to southeast. Scattered throughout the broader areas are many wind-scoured hollows. This soil is mainly in the vicinity of Caruthers, Raisin City, and Burrel. Some areas lie a few miles southwest of Kerman.

About 17 percent of the acreage is underlain by a compact silty layer at a depth of more than 4 feet. A few small areas are included in which the substratum is at a depth of less than 4 feet. In about 30 percent of the unit the reaction of the underlying material is strongly alkaline. The reaction is readily lowered by simple leaching. Many of the wind-scoured hollows are occupied by small playas or small areas of El Peco, Fresno, Pond, or Traver soils that are saline-alkali affected.

Soil blowing is a moderate hazard, particularly on windward slopes. The use and management of this soil are similar to those of Calhi loamy sand, 0 to 3 percent slopes. If the soil is irrigated, the sprinkler method is commonly used. The wind-scoured hollows containing playas or saline-alkali soils are frequently ponded under sprinkler irrigation. This is somewhat helpful at first in reclaiming these affected spots. Later, however, care and timing in sprinkler settings are needed in order to avoid drowning of crops in these low spots. Capability unit IIIs-4 (17); range site not assigned; natural land type A5; Storie index rating 68.

Calhi loamy sand, moderately deep, 0 to 3 percent slopes (CgA).—This soil has a profile similar to that described as typical for the series, but it overlies a compact, calcareous, silty substratum at a depth ranging between 2½ to 4 feet. The substratum is fractured, tunneled by burrowing animals, or exists as many small lenses of variably layered silty material separated by sandy layers. It slows, but does not severely impede, internal drainage except in places where the silty material is lime or lime-silica cemented.

In about 15 percent of the area the reaction of the underlying material is strongly alkaline. Also, in places, there is a slight accumulation of soluble salts. This condition is readily improved by simple leaching. Where the material is silty, however, it may remain saline-alkali affected for a longer period.

Included with this soil in mapping were small areas of saline-alkali affected Hesperia, Traver, Pond, El Peco, and Fresno soils that occupy minor depressions. Natural vegetation or crop growth is depressed or absent in these spots.

The use and management of this soil are similar to those of Calhi loamy sand, 0 to 3 percent slopes. The underlying material helps to hold somewhat more water in the soil and thereby permits a slightly longer period between irrigations. Under sprinkler irrigation, the included soils in depressed spots are often flooded. Capability unit IIIs-4 (17); range site not assigned; natural land type A6; Storie index rating 77.

Centerville Series

The Centerville series consists of well-drained, clayey soils that formed from the weathering of weakly to moderately consolidated old alluvial deposits. These deposits are of poorly sorted, mixed material, mainly derived from metamorphic and basic igneous rocks.

These soils are gently undulating to strongly sloping

or rolling; they occupy old, degraded alluvial terraces. Within the survey area the soils are distributed from the vicinity of Friant to that of Centerville and Tivy Valley. They are at elevations of 400 to 700 feet. According to elevation, the annual rainfall ranges from 12 to 15 inches. The average annual temperature is about 62° F., and the average frost-free season is 275 days per year. The natural vegetation consists of annual grasses and forbs.

In a typical profile, the surface layer is dark-gray, slightly acid clay about 20 inches thick. The subsurface layer is dark reddish-brown, calcareous, mildly alkaline clay, which grades abruptly to compact, weathered alluvial sediments at a depth of 32 inches. Occasional rounded cobblestones and pebbles occur on the surface.

These soils are used principally for grazing. In areas of these soils where the frost hazard is minimal, some orange groves have been established. Irrigation water is obtained by pumping from deep wells. Sources of water for livestock are limited to a few small intermittent streams and to shallow wells pumped by windmills.

Representative profile on a southerly slope of 2 percent, on a degraded high alluvial terrace at an elevation of about 540 feet, in range pasture having a dense cover of annual grasses and forbs (2 miles NNE. of Centerville; 900 feet N., 800 feet W. of utility bridge that crosses the Friant-Kern Canal near the corner of McKinley and Lac Jac Avenues in the SE¼SE¼ sec. 29, T. 13 S., R. 23 E.):

A11—0 to 20 inches, dark-gray with a reddish tint (5YR 4/1) clay, dark reddish brown (5YR 3/2) when moist; strong coarse and medium angular blocky structure; prominent, deep cracks in surface when dry; very hard when dry, very firm when moist, sticky and plastic when wet; plentiful fine roots in upper part, diminishing to few with depth; few fine tubular pores well coated with clay films; few slickensides and pressure faces on peds; occasional rounded cobblestones and pebbles scattered on the surface or within the horizon; slightly acid (pH 6.5); clear, wavy lower boundary.

A12—20 to 32 inches, dark reddish-brown (5YR 3/2) clay, dark brown (7.5YR 3/2) when moist; strong, coarse, angular blocky structure; very hard when dry, very firm when moist, sticky and plastic when wet; few to no fine roots; very few fine tubular pores; numerous slickensides on ped faces; occasional rounded cobblestones and pebbles in horizon; numerous fine lime nodules; mildly alkaline (pH 7.5); abrupt, wavy lower boundary.

C—32 inches +, rounded cobblestones and pebbles of metamorphic and basic igneous rocks imbedded in weathered feldspathic sandy material that is intermittently calcareous and light brown to reddish yellow; lime seams and lime encrustations on some cobblestones or pebbles are pinkish white; sandy material is extremely hard when dry, but when moistened it slakes to a friable mass, which becomes clayey and sticky when worked; mildly alkaline (pH 7.8); many feet thick.

The A11 horizon is uniformly dark colored, but ranges from dark gray that has a reddish tint, through dark reddish brown to dark brown and in some places dark grayish brown (5YR 4/1, 3/2, 4/2, 7.5YR 3/2, 4/2; 10YR 4/2). Moist color is dark gray, dark reddish gray, dark reddish brown, dark brown, or very dark brown (5YR 4/1, 4/2, 3/2, 7.5YR 3/2, 4/2; 10 YR 4/1, 2/2). The color of the A12 horizon is similar to that of the A11 horizon, but in places it is about one unit lighter or brighter in value and chroma when moist or dry. Texture of the A11 and A12 horizons is clay, gravelly clay, or cobbly clay. The reaction of the A11 horizon ranges from slightly acid to neutral. The A12 horizon ranges from mildly to moderately alkaline, and fine lime nodules are common.

A thin, firm, limy layer of very limited extent is at the boundary between the solum and the parent material in some places. Where this layer occurs, generally no free lime is found in the layer above. Where lime nodules commonly occur in the A12 horizon, soft, vertical seams of lime extend a few inches into the C horizon. The C horizon is cobbly or gravelly in some places, but not in others. Where cobblestones or pebbles occur in the C horizon, they commonly are partly lime coated in the upper parts of the horizon.

Centerville clay, 0 to 3 percent slopes (ChA).—This soil has the profile described as typical for the series. It is gently sloping to gently undulating and occupies parts of old, degraded alluvial terraces.

Runoff is slow. In many places the natural surface of this soil is laced with very shallow meandering drainageways. Most of these drainageways carry the surface water away from the soil, but some of them end in shallow depressions that are ponded during the rainy season. The permeability is very slow after the soil has become thoroughly wet and all cracks have closed. The available water holding capacity is high. The hazard of erosion is slight to none.

In the vicinity of Clovis, Academy, and Round Mountain, areas of this soil occur with soils on low terraces. Near Centerville and Tivy Valley, they occupy parts of high alluvial terrace remnants.

Included with this soil in mapping was a small area on Kirkman Hill in which the dark clay overlies a cobbly hardpan. Also included were small areas of a soil that is similar to this soil but is somewhat more cobbly or gravelly. In places the cobblestones and gravel make up as much as 20 to 30 percent of the soil mass, by volume. These included soils are located entirely on the high terrace remnants near Centerville and Tivy Valley.

Most of this soil is used for range. The forage plants respond well to nitrogen and phosphorus fertilizers. Some areas are planted to dryfarmed barley in association with other more extensive soils of the terraces. Successful citrus groves have been established near Centerville where the soil has good air drainage and a relatively low frost hazard. Nitrogen is applied as a fertilizer either in manure or commercial form. Cultivation is difficult if the soil is too dry or too wet. Tillage operations should be timed to a moist soil somewhat below field capacity, but not air dry. Where the soil is not tilled, weeds are controlled by using oil-based sprays. Compaction by tractors or vehicles occurs during the harvest period if the soils are wet from rain. This is often ameliorated by subsequent shrinking and swelling of the clay upon drying and wetting several times. Irrigation water is applied through furrows or low-set sprinklers. Capability unit IIs-5 (17); range site 3; natural land type E2; Storie index rating 35.

Centerville clay, 3 to 15 percent slopes (ChC).—This soil is similar to Centerville clay, 0 to 3 percent slopes. It is in small or medium-sized areas on gently

rolling knolls or moderate slopes that have been carved from, or worn into, old alluvial terrace deposits from mixed rocks. Runoff is medium, and the hazard of erosion is slight to moderate. Under very wet conditions without protective vegetation, this soil can be subject to mass movement downslope.

Included with this soil in mapping was a small area on Kirkman Hill in which the dark clay lies abruptly on a cobbly hardpan.

Centerville clay, 8 to 15 percent slopes, is used mainly for range. Forage responds well to nitrogen and phosphorus. Citrus groves have been established near Centerville. Cultivation for weed control in the citrus groves should be across the slope where possible. Irrigation in the groves is by contour furrows or low-set sprinklers. Capability unit IIIe-5 (17); range site 3; natural land type E2; Storie index rating 30.

Centerville cobbly clay, 3 to 9 percent slopes (CkB).—The profile of this soil is similar to that described for the series, except that rounded gravel and cobblestones of resistant rock make up 20 to 30 percent of the volume. This soil is gently to moderately sloping and lies on the flanks and old, alluvial terrace remnants near Centerville and Tivy Valley.

Centerville cobbly clay, 3 to 9 percent slopes, is well drained. Runoff is slow or medium, and the erosion hazard is slight to moderate. Because it is cobbly, this soil is difficult or impractical to cultivate and is used only for grazing. The cobblestones do not prevent surface application of fertilizers, and the forage plants respond well to both nitrogen and phosphorus. Capability unit IIIe-5 (17); range site 3, natural land type E2; Storie index rating 25.

Centerville cobbly clay, 9 to 30 percent slopes (CkD).—The profile of this soil is similar to that described as typical for the series, but the content of cobblestones and gravel ranges from about 20 to 40 percent. This soil is strongly sloping to moderately steep on the side slopes of high alluvial terrace remnants. It occurs in many areas near Centerville and Tivy Valley, and southeast of Friant. Runoff is medium to rapid.

This soil is too cobbly and, in many places, too steep for practical cultivation. It is used for grazing; the growth of forage is fair to good. Fertilization with nitrogen and phosphorus is practical. Capability unit IIIe-5 (17); range site 3; natural land type E2; Storie index rating 22.

Chino Series

The Chino series consists of stratified soils that formed in granitic alluvium in which the natural drainage was somewhat poor. The soils are presently moderately well drained. Drainage has been improved by local pumping and by controlling the flow of rivers and streams. These soils occupy lower parts of the recent alluvial fans along both the Kings and the San Joaquin Rivers, as well as recent flood plains of small streams in the vicinity of Navelencia and Orange Cove.

These soils originally were nearly level to gently undulating, but few natural areas remain. Most of the acreage has been leveled and developed for irrigation. These soils range in elevation mainly from about 160 to 200 feet in the valleys, but some areas near the lower edge of the foothills lie at about 500 feet. The average annual precipitation is about 8 inches at the lower elevations and about 14 inches near the foothills. The average annual temperature is about 62° F.

The average growing season ranges from about 250 to 275 days, but on the Kings River fan near Riverdale, it is only about 225 days. The natural vegetation consists mainly of annual grasses, perennial grasses, herbs, shrubs, and willows.

In a typical profile, the surface layer is gray, neutral to moderately alkaline loam about 12 inches thick. This is underlain by a subsurface layer of grayish-brown, moderately alkaline clay loam to fine loam about 6 inches thick. The underlying material is grayish-brown and pale brown fine sandy loam. The lower parts are generally calcareous and are mottled.

If these soils are irrigated, they are suited to cotton, alfalfa, sugar beets, corn, grain sorghum, barley, and pasture. Nonirrigated, undeveloped areas are used for grazing.

Representative profile in a nearly level pasture of native perennial grasses and weeds, in a riparian area at an elevation of about 165 feet (8 miles NE of Mendota in the NW¼ SE¼ NW¼ sec. 21, T. 13 S., R. 15 E.):

A11—0 to 8 inches, gray (10YR 5/1) loam, very dark brown (10YR 2/2) when moist; strong, medium, granular structure; slightly hard when dry, friable when moist, slightly sticky and very slightly plastic when wet; abundant very fine roots, plentiful fine roots; many very fine tubular pores; neutral (pH 7.0); abrupt, wavy lower boundary.

A12—8 to 12 inches, gray (10YR 5/1) loam, very dark gray (10YR 3/1) when moist; moderate, medium, angular blocky structure; hard when dry, firm to friable when moist, slightly sticky and slightly plastic when wet; plentiful very fine roots, few fine roots; many very fine and medium tubular pores; organic stains on ped faces and in pores; moderately alkaline (pH 8.0); abrupt, wavy lower boundary.

A13—12 to 18 inches, grayish-brown (10YR 5/2) clay loam, very dark gray (10YR 3/1) when moist; moderate, coarse, angular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; plentiful very fine roots, few fine roots; many very fine and medium tubular pores; clay films and organic stains continuous in pores; slightly effervescent with disseminated lime; moderately alkaline (pH 8.0); clear, wavy lower boundary.

IIC1—18 to 25 inches, grayish-brown (10YR 5/2) heavy fine sandy loam, dark brown (10YR 4/3) when moist; few, fine, faint mottles; weak, medium, blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful very fine roots, few fine roots; many very fine tubular pores; few thin clay films on some ped faces; slightly effervescent from lime segregated in fine soft masses; moderately alkaline (pH 8.0); clear, smooth lower boundary.

IIC2—25 to 60 inches, pale-brown (10YR 6/3) fine sandy loam, yellowish brown (10YR 5/4) when moist; many, medium, faint, light-gray (10YR 7/1) mottles, grayish brown (10YR 5/2) when moist; massive; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; few fine and very fine roots; common very fine tubular pores; very slight effervescence from disseminated lime; mildly alkaline (pH 7.5).

The color of the A horizon ranges from gray to grayish brown. The hue is 10YR, the value is 5, and the chroma is 1 or 2. Moist colors range from very dark gray to very dark brown. The hue and chroma remain the same as for dry colors but value is only to 2 or 3. The texture of the A11 horizon and A12 horizon is sandy loam, fine sandy loam, or loam. The A horizon has weak to strong fine to medium, granular or blocky structure. The consistence ranges from slightly hard to hard when dry, and friable to firm when moist. The reaction ranges from neutral to mildly alkaline. The lower parts of the A horizon are generally calcareous and somewhat finer textured. Where the horizon is saline-alkali affected, the reaction is commonly more strongly alkaline.

The color of the C horizon ranges from grayish brown to pale brown. The hue is generally 10YR, but in some places it is 2.5Y. The value ranges from 5 to 6, and the chroma from 2 to 3. Moist colors range from dark grayish brown to yellowish brown. The hue is similar, but the value ranges from 4 to 5 and the chroma from 2 to 4. If the hue is 2.5Y the chroma is not brighter than 2.5, dry or moist. Generally there is mottling in the lower parts of the C horizon. Mottles range from faint to prominent, few to many, fine to large, and in places are red, yellowish red, yellowish brown or strong brown. Between depths of 10 and 40 inches, the texture ranges from heavy fine sandy loam to clay loam. Below 40 inches, it is similar or somewhat coarser. The structure ranges from weak to moderate, medium or coarse blocky. In places the horizon is massive. The consistence is hard or very hard when dry, friable to firm when moist, and slightly sticky or nonsticky when wet. The C horizon is generally moderately alkaline and calcareous, although variable in amounts of lime. Where it is saline-alkali affected, it is more strongly alkaline.

These soils are typically very deep, but in places, they overlie a compact silty substratum or thick layer of sand at a depth of 2½ to 4 feet.

Chino loam (0 to 2 percent slopes) (Cr).—A profile of this soil is described as typical for the series. The permeability is moderate; runoff is slow. The available water holding capacity is high, and the hazard of erosion is slight to none.

This soil is near Whites Bridge on the recent fan of the San Joaquin River and on the recent fan of the Kings River in the Riverdale-Burrel district. Most of the acreage has been leveled and developed for farming. Some areas, however, remain in their natural state along the rivers.

Included with this soil were small areas of a similar soil having a clay loam surface layer that overlies a compact unrelated substratum at about 3 feet.

Field crops, such as alfalfa, cotton, corn, grain sorghum, and sugar beets, are well suited to Chino loam. Some irrigated barley is grown, and much of the soil is used for irrigated pasture for both dairy and beef livestock. Irrigation water is obtained mainly by pumping from deep wells and is generally of good quality. Some undesirable amounts of boron are in the ground water west of Riverdale, where some areas of this soil lie. The high available water holding capacity permits less frequent irrigation in comparison to sandier soils. Nitrogen and phosphorus fertilizers are required for good growth. Undeveloped areas are used for grazing. They provide good forage near the rivers, where some shade is offered by willow trees. Capability unit I-1 (17, 18); range site not assigned; natural land type A1–1f; Storie index rating 95.

Chino fine sandy loam (0 to 2 percent slopes) (Co).—This soil has a profile similar to that described as typical for the series, but the surface layer is fine sandy loam. The soil is located in the same general area as Chino loam.

The use and management of this soil are similar to those of Chino loam, but the surface soil is somewhat more easily tilled, and less cloddy seedbed is more easily obtained. Capability unit I-1 (17, 18); range site not assigned; natural land type A1–1f; Storie index rating 95.

Chino fine sandy loam, saline-alkali (0 to 2 percent slopes) (Cs).—Except that it is saline-alkali affected and has a fine sandy loam surface layer, the profile of this soil is similar to that described as typical for the series. This soil is located in the Riverdale-Burrel district.

The surface layer shows indications of saline-alkali conditions in about half the acreage. These indications consist of spotty areas of depressed crop growth or no growth, and they appear on 5 to 33 percent of the surface of a given area. The surface layer in these areas is strongly alkaline and contains at least a slight amount of soluble salts. The rest of the unit consists of areas in which all of the surface layer is saline-alkali free, but these areas are affected in most layers below a depth of 12 to 15 inches. The depression in crop growth in the latter areas is more uniform.

Field crops are fairly well suited without reclaiming the soil. The water table has been lowered sufficiently by pumping to make reclamation and improvement of this soil practical. The section on "Saline and Saline-Alkali Soils" discusses the methods used in this area. Capability unit IIs-6 (17); range site not assigned; natural land type A1–1f 2s; Storie index rating 57.

Chino fine sandy loam, moderately deep, saline-alkali (0 to 2 percent slopes) (Cp).—This soil overlies compacted, silty material at a depth of 30 to 48 inches. In addition, the soil material above the underlying material, excluding the surface layer to a depth of about 12 inches, is strongly alkaline and is at least slightly saline. Otherwise, the profile of this soil is similar to that described as typical for the series.

The underlying material slows the free downward drainage of water in the soil, but it does not seriously restrict it. The material is commonly fractured or penetrated by burrowing animals. Roots, however, are unable to develop freely within the silty material. Because of this, the available water holding capacity of the soil ranges from medium to high, depending on the depth to the compacted soil material.

Areas of this soil are located in the Riverdale-Burrel district bordering the basin rim lands. Included in mapping were some small areas of a similar soil that is saline-alkali free.

Without reclamation, only fair to poor growth of field crops can be expected. Irrigated pastures do well; the shallow-rooted forage grasses establish themselves readily in the saline-alkali free surface layer. Reclamation of this soil is somewhat slower than for a similar soil without the compacted substratum, but nevertheless it is practical. The use and management of reclaimed areas of this soil are similar to those

needed for Chino loam, but continued care is needed in avoiding the return of the salts or alkali. Capability unit IIIs-6 (17); range site not assigned; natural land type A2-1f-2s; Storie index rating 58.

Chino loam, saline-alkali (0 to 2 percent slopes) (Cs).—Below a depth of about 12 inches, this soil is strongly alkaline and at least slightly saline. In addition, areas of this soil making up about half of the acreage are similarly affected by salts and alkali in the surface layer. However, the accumulations are variable and occur in scattered spots that occupy 5 to 66 percent of the surface of the affected areas. In all other respects, the profile of this soil is similar to that described as typical for the series.

This soil is mainly in the locality of Whites Bridge, Riverdale, and Lanare. Some small areas are also located near Navelencia along main streamways.

If this soil is reclaimed, its use and management are similar to those of Chino loam. Without reclamation, very irregular growth of field crops is obtained. Areas of this soil having a saline-alkali free surface layer are well suited to irrigated pasture. Continued use as irrigated pasture leaches excess salts downward in the lower horizons and helps in reclaiming the whole soil. This is more effectively accomplished if occasional irrigations are heavy enough to wet the soil to a depth of at least 4 feet. Capability unit IIs-6 (17); range site not assigned; natural land type A1-1f-2s; Storie index rating 57.

Chino sandy loam (0 to 2 percent slopes) (Cl).—This soil has a sandy loam surface layer but otherwise has a profile like that of Chino loam. The next layer, to a depth of about 40 inches, varies somewhat in texture; it ranges from heavy sandy loam to sandy clay loam. Below a depth of 40 inches, the soil material generally is variably stratified with moderately coarse textured and medium-textured materials. The available water holding capacity is medium to high.

Areas of this soil are in the vicinity of Whites Bridge, Riverdale, and Laton on the recent river fans, and in the vicinities of Clovis, Clark Valley, Citrus Cove, and Orange Cove on small stream fans or flood plains. In the vicinity of Riverdale, the soil contains very prominent, reddish or yellowish mottles in the coarser textured layers in the lower part of the underlying material.

Included in mapping was a small area of this soil northwest of Riverdale that overlies a compact silty substratum at a moderate depth.

Somewhat more frequent irrigation is required for Chino sandy loam than for Chino loam, so that moisture is adequate for irrigated crops. The use and management of this soil are otherwise similar to those of Chino loam. Capability unit I-1 (17, 18); range site not assigned; natural land type A1-1f; Storie index rating 90.

Chino sandy loam, saline-alkali (0 to 2 percent slopes) (Cm).—The surface layer of this soil is sandy loam and the underlying material to a depth of about 40 inches is variable, ranging from heavy sandy loam to sandy clay loam. Most areas of this soil have 5 to 33 percent of the surface layer saline-alkali affected. The underlying material is more uniformly affected. It is strongly alkaline but varies from place to place in the amount of excess accumulation of both neutral and basic salts.

Included in areas mapped as this soil are a few areas that are saline-alkali free to a depth of 12 to 15 inches. Also included are areas in which 33 to 66 percent of the surface layer is affected.

Nearly all of the areas of this soil are located in the Riverdale-Burrel district. One area is near Whites Bridge.

Without reclamation of the soil, growth of field crops is variable and only fair at best. Reclamation of this soil is feasible and practical. As with most saline-alkali soils, continued care is needed after reclamation to avoid the return of the salt or alkali. Capability unit IIs-6 (17); range site not assigned; natural land type A1-1f-2s; Storie index rating 54.

Chualar Series

The Chualar series consists of deep, moderately well drained soils that have a moderately slowly permeable subsoil. These soils formed in older granitic alluvium that filled many small valleys in the foothills. The soils occupy somewhat depressed positions along small streams draining the valleys, or they occupy the nearly level to moderately sloping floor of very small valleys. In most places they are subject to slow, but not excessive, seepage from surrounding soils of the uplands. As a result, Chualar soils are generally moist for a longer period during the year than adjacent soils, and they support a late growth of green plants into the early dry period of summer. The natural vegetation consists of annual grasses, forbs, and a scattering of blue oak or valley oak.

The soils are widely distributed in many small areas at elevations ranging from 500 to 2,500 feet. Average annual precipitation increases with elevation, ranging from about 15 to 24 inches. The average annual temperature decreases with elevation, ranging from about 62° to 57° F. The average growing season ranges from about 175 to 225 days. Some areas at lower elevations are in valleys having good air drainage. They have a longer frost-free period. Other areas are in valleys that trap cold air and become frost pockets early in fall or late in spring; consequently, they have a shorter frost-free season.

A typical profile has a grayish-brown sandy loam surface layer that is neutral and about 6 inches thick. The subsoil is dark-gray to pale-brown sandy clay loam about 32 inches thick. The substratum is a pale brown mildly alkaline sandy loam that extends to a depth of 60 inches or more.

Chualar soils are used for range or pasture. They are often grazed intensively late in the season because of their cover of green forage. In many areas there is overdeepening of natural drainageways. The massiveness of the surface layer is attributed to trampling by grazing animals.

Representative profile in rangeland on a smooth east-facing slope of 3 percent, at an elevation of about 700 feet, under vegetation of annual grasses and forbs

and scattered blue oak (3¼ miles, airline, NE. of Academy in the S½SE¼NW¼ sec. 36, T. 11 S., R. 22 E.):

A1—0 to 6 inches, grayish-brown (10YR 5/2) sandy loam near loam, very dark grayish brown (10YR 3/2) when moist; massive, breaking to coarse angular blocks; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant fine and very fine roots; few fine and many very fine tubular pores; neutral (pH 7.0); clear, smooth lower boundary.

B21t—6 to 25 inches, dark-gray (10YR 4/1) sandy clay loam, very dark gray (10YR 3/1) when moist; moderate to strong, medium, prismatic structure; very hard when dry, firm when moist, slightly sticky and slightly plastic when wet; abundant fine and very fine roots; many fine tubular pores; few thin clay films on ped faces, many thin clay films in pores; neutral (pH 7.0); abrupt, smooth lower boundary.

B22t—25 to 38 inches, pale-brown (10YR 6/3) sandy clay loam, dark brown (10YR 4/3) when moist; moderate to strong, coarse, angular blocky structure; very hard when dry, firm when moist, slightly sticky and slightly plastic when wet; plentiful very fine roots; many very fine and fine tubular pores; many thin clay films on ped faces and in pores; mildly alkaline (pH 7.5); clear, smooth lower boundary.

C—38 to 60 inches, pale-brown (10YR 6/3) light sandy clay loam, brown (10YR 5/3) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; many medium tubular pores; mildly alkaline (pH 7.5).

The color of the A horizon ranges from grayish brown to dark grayish brown. The hue is generally 10YR, the value is 4 or 5, and the chroma is 2 or 3. Moist colors range from very dark brown to very dark grayish brown; the hue remains the same, but the value is 2 or 3 and the chroma is 2. The A horizon is massive and hard or very hard when dry but friable when moist. Reaction ranges from slightly acid to neutral. Texture ranges from sandy loam to loam.

The Bt horizon is darker colored in its upper part than in the lower; the color ranges from grayish brown to dark gray. The hue is 10YR, value is 4 or 5, and chroma is 1 or 2. Moist colors range from dark grayish brown to very dark gray. The hue and chroma remain the same as for a dry horizon, but the value is only 3 or 4. The lower parts of the Bt horizon lighten to brown or pale brown, and they are brown or grayish brown when moist. Texture is sandy clay loam or clay loam. The reaction ranges from neutral to mildly alkaline.

The C horizon ranges from light brownish gray to light yellowish brown in color. The hue is 10YR, the value is 6, and the chroma ranges from 2 to 4. Moist colors range from grayish brown to yellowish brown; they have the same hue and chroma, but the value is 5. Texture of the C horizon varies from sandy loam to light sandy clay loam. The C horizon is generally mildly alkaline, but in places it is moderately alkaline and intermittently calcareous.

Chualar sandy loam, 0 to 3 percent slopes (CtA).—This soil has the profile described as representative for the series. The soil is nearly level to very gently sloping and occupies parts of small valleys in the foothills. It is moderately well drained as a result of seepage. Runoff is slow. The available water holding capacity is high, and the hazard of erosion is slight. Permeability is moderately slow.

Included with this soil in mapping were areas of a soil having a loam surface layer that contains enough coarse sand to cause a gritty feeling when handled. Other inclusions are two small areas, in the foothills north of Academy, of a similar soil with a clay loam surface layer. Also included, in Squaw Valley, is an area of Chualar sandy loam that is underlain by a compact, unrelated, hard substratum at about 2 feet.

Chualar sandy loam, 0 to 3 percent slopes, is used for range in association with other extensive soils in grass. Reliable sources of water are not available for irrigation in most places. Where this soil can be more intensively managed, it provides good sites for dryland pasture. The forage on this soil responds well to fertilization with nitrogen and phosphorus. Legumes are stimulated in growth by application of sulfur. Capability unit I-1 (17, 18); range site 4; natural land type C2; Storie index rating 81.

Chualar sandy loam, 3 to 9 percent slopes (CtB).—This gently to moderately sloping soil occupies parts of small valleys in the foothills. It has a profile similar to that described as representative of the series.

This is the best drained soil of the Chualar series, but it is subject to seepage during the spring and early in summer. Runoff is medium, and the erosion hazard is slight to moderate.

The use and management of this soil are similar to those of Chualar sandy loam, 0 to 3 percent slopes. Somewhat greater care is needed to avoid overgrazing so that the hazard of erosion is kept to a minimum. Capability unit I-1 (17, 18); range site 4; natural land type C2; Storie index rating 73.

Cibo Series

The Cibo series consists of well drained to excessively drained, clayey soils that are moderately deep over well-weathered basic igneous rock, mainly gabbro or diorite. These soils are undulating to very steep and well drained to somewhat excessively drained. Most areas are studded with rock outcrops or detached stones or boulders.

These soils are irregularly distributed along the lower edge of the foothills. They are mainly on prominent hills or ridges, some of which are conspicuous fault block outliers surrounded by the alluvial fill of the eastern part of the San Joaquin Valley. The soils are at elevations of 400 to 2,000 feet. At the higher elevations, they are on southerly or westerly facing slopes. The average annual rainfall ranges from 14 to 17 inches, the average annual temperature from 62° to 60° F., and the average growing season from about 225 to 275 days. The natural vegetation consists entirely of annual grasses and forbs.

Typically, the Cibo soils have a dark-gray or dark grayish-brown, neutral to mildly alkaline clay overlying weathered bedrock at about 23 inches. As it dries, the soil forms deep, conspicuous cracks and becomes very hard. Considerable granulation of the surface layer takes place on thorough drying and this causes untrampled areas to feel somewhat spongy to the step. Much granular material falls into the deep cracks. Minor amounts of lime are generally accumulated at or near the transition into the weathered parent rock.

The rock outcrops are generally low, angular, and dark in color; they stand not more than 5 feet above

the surface in most places. These outcrops occur in clusters or singly, and in most places they are not more than 10 feet in rough cross section.

Sources of water are generally quite limited on these soils. Some springs and short, intermittent streams provide seasonal amounts of water for livestock. Some small dams are built across the small streams to conserve the seasonally available water.

Cibo soils are used mainly for range, to which they are well suited. A large part of one of the better range sites in the survey area is on these soils. Some of the less steeply sloping, rock-free areas of these soil are used for dryfarmed barley.

Representative profile on a very steep southeast-facing slope of about 52 percent, in an ungrazed area of rangeland at an elevation of about 550 feet; angular stones and rock outcrops occupy about 10 percent of surface; the vegetation is annual grasses and forbs (2 miles SW. of Piedra on N. side of Trimmer Springs Road near the S. quarter-corner of the NE1/4SW1/4 sec. 18, T. 13 S., R. 24 E.):

A11—0 to 8 inches, dark gray (10YR 4/1) light clay, very dark gray (10YR 3/1) when moist; massive when moist, crusting to coarse and medium subangular blocks that break further into fine granules; hard to very hard when dry, friable to firm when moist, very sticky and plastic when wet; plentiful very fine roots; deep cracks filled with granulated fragments; many medium and fine interstitial pores between blocks and granules; neutral (pH 7.0); abrupt, wavy lower boundary.

A12—8 to 19 inches, clay that is similar in color to A11 horizon; moderate, very coarse prismatic or blocky structure; pressure faces and weak slickensides on vertical and canted faces; very hard when dry, friable to firm when moist, very sticky and plastic when wet; few to plentiful very fine roots; very few tubular pores; neutral (pH 7.0); abrupt, irregular lower boundary.

A13—19 to 23 inches, dark grayish brown (10YR 4/2) clay; very dark grayish brown (10YR 3/2) when moist; moderate, coarse, blocky structure; weak slickensides; consistence similar to that in A12 horizon; few very fine roots; no obvious pores; mildly alkaline (pH 7.5); very abrupt, irregular lower boundary.

C—23 inches +, light-gray to gray, variegated with greenish gray, well-weathered, coarse-grained hornblende gabbro diorite; rock fabric still clearly visible; variable lime coatings on weathered rock fragments in upper part; grades to unweathered rock at depth exceeding 10 feet.

Color of the A11 horizon is consistently dark, ranging from dark gray to dark grayish brown, or very dark brown to dark brown (10YR 2/2, 4/1, 4/2; 7.5YR 3/2). In a few places it is dark reddish brown (5YR 3/2). When the horizon is moist, the hue remains about the same, the value is 2 or 3 and the chroma is 1 or 2. Texture of the A11 horizon is typically clay but ranges to clay loam in places. The A11 horizon is neutral or slightly acid. The strong tendency to crack on drying favors the granulation of the surface layer.

Colors and texture of the A12 and A13 horizons are similar to those of the A11 horizon, but both dry and moist colors increase about one unit in value or chroma. Reaction is neutral to mildly alkaline or moderately alkaline. Minor amounts of segregated lime occur in places. Surface cracking penetrates well into the subsurface horizons, but less distinctly and continuously in the lower horizons.

The C horizon is weathered strongly enough in places to have lost the pattern of the original rock fabric. Slightly weathered or unweathered angular stones or cobblestones of parent rock are commonly found within the solum as float rock. The depth of soil to the weathered rock varies greatly, commonly within short distances. Depth ranges from about 20 to 60 inches.

Angular, dark-colored rock outcrops are typical of the Cibo soils in this survey area. However, some areas are free of outcrops. These commonly are gently sloping.

Cibo very rocky clay, 45 to 70 percent slopes (CvF).—This soil is located almost entirely south of the Kings River on Tivy and Jesse Morrow Mountains. All areas are on south-facing slopes.

This soil is somewhat excessively drained. Runoff is slow to medium early in the rainy season when the soil is dry, but it is rapid after the soil becomes wet and its deep cracks are closed by swelling. The permeability of the subsoil is slow. The available water holding capacity ranges from low to high, depending upon the depth of soil. The hazard of erosion from running water is moderate to high, but slumping of the soil while saturated is a great hazard.

There is a greater tendency for this soil to creep downslope than for most of the other soils on uplands. This is indicated by the surface patterns streaming downslope, which are easily seen from the air or from a distance on the ground. The patterns result from numerous, parallel, shallow troughs that are several feet across. They do not appear to be healed gullies, but instead they are the marks of slow mass movement downslope. Large areas of colluvial clay skirt the base of these very steep slopes and can be traced upslope, where they merge gradually with the Cibo soils in the shallow troughs and on the low divides between troughs.

The surface rockiness is variable from place to place. Most areas of this soil have 10 to 25 percent of their area occupied by outcrops, but some have as much as 50 percent.

Included with this soil in mapping were a few minor areas having no outcrops.

This soil is used only for range. It produces good growth of forage, including much clover. However, the steepness of the slopes significantly reduces the grazing intensity by livestock. Development of stock trails and suitable placement of salt licks help to gain better distribution of animals and better use of the available forage. Some small ponds for livestock have been formed by excavating and by damming suitable small streamways well up on the steep slopes. Fertilization is generally not practical because of the steep slopes and high cost of application. The rock outcrops provide refuge sites for small wildlife. Capability unit VIIs-8 (18); range site 3; natural land type E12; Storie index rating 7.

Cibo clay, 3 to 15 percent slopes (CuC).—This soil is similar to Cibo very rocky clay, 45 to 70 percent slopes, except that it is free of rock outcrops and has less slope. The depth to weathered rock ranges mainly from about 30 to 50 inches, but in places it is as much as 60 inches. The underlying weathered rock is many feet thick. The soil is well drained. Runoff is slow to medium. The hazard of erosion is slight.

Areas of this undulating to rolling soil are along the lower edge of the foothills and on the lower slopes of some foothill outliers.

Included with this soil in mapping was a small area of a similar soil that is nearly level to gently undulating and another soil that is cut by shallow gullies. Both included soils lie near Round Mountain. Also included is still another small area, on the west flank of Owens Mountain, of a similar soil that has a surface layer of clay loam

Some of the larger areas of Cibo clay, 3 to 15 percent slopes, are used for dryfarmed barley. The rest of the soil is used for range or pasture and is well suited to this use. Fertilization with nitrogen is practical, giving significant increases in forage production. The soil lies in the zone of minimum frost hazard. Where reliable sources of irrigation water are available, this soil can be used for citrus plantings. Capability unit IIIe 5 (17); range site 3; natural land type E2; Storie index rating 38.

Cibo clay, 15 to 30 percent slopes (CuD).—This soil is free of rock outcrops and is hilly. Its profile is similar to that described as representative of the series. It occurs in small areas. The depth to the underlying weathered rock ranges from about 24 to 50 inches.

This soil is well drained. Runoff is medium to rapid after the soil is wet and the numerous surface cracks have been closed. The hazard of erosion is slight to moderate.

Included with this soil was a small area, on the west flank of Owens Mountain, of a similar soil that has a surface layer of clay loam.

Cibo clay, 15 to 30 percent slopes, is used only for grazing. Some areas are in locations favorable for management as dry pasture, but most are used only for range in association with other more extensive rangeland areas. A few areas near sources of water have been put under sprinkler irrigation for pasture. Nitrogen fertilization is practical; it increases forage production. Capability unit IVe 8 (18); range site 3; natural land type E2; Storie index rating 29.

Cibo clay, 30 to 45 percent slopes (CuE).—This soil has a profile similar to that described as representative of the series, but is essentially free of rock outcrops or stones. Depth to weathered rock ranges from about 24 to 50 inches. Drainage is somewhat excessive. Runoff is rapid, and the erosion hazard is moderate. This steep soil is distributed in several areas on ridge slopes northeast of Centerville, east and northeast of Round Mountain, and on Tivy Mountain

Included with this soil were some areas that have small clusters of outcrops and areas where there is shallow gully erosion. A small area of stony clay formed from basalt has also been included. This area lies southeast of Friant near the end of the train of erosional remnants of the ancient Table Mountain volcanic flow.

Cibo clay, 30 to 45 percent slopes, is used for range in association with other more extensive areas in grassland Fertilization is practical, and the forage responds well to nitrogen applications. Surface application is somewhat difficult on the steep slopes. Capability unit VIe-8 (18); range site 3; natural land type E10; Storie index rating 15.

Cibo very rocky clay, 3 to 30 percent slopes (CvD).—This soil is undulating to hilly, otherwise it is similar to Cibo very rocky clay, 45 to 70 percent slopes. Rock outcrops occupy about 10 to 25 percent of the surface area. Depth of soil material to weathered rock ranges from about 24 to 50 inches.

This soil is well drained. Runoff is medium to rapid after the soil is wet sufficiently to close the many surface cracks by swelling. The hazard of erosion is slight to moderate. The outcrops provide some natural terracing effects in places.

The soil is mainly on foothill outliers in the valley areas, such as Smith Mountain, Jesse Morrow Mountain, Granite Hill, and small unnamed hills in the vicinity of Academy. Areas are also located on the south and west slopes of Tivy Mountain

The forage from this soil provides good range grazing Compared to similar rock-free soils, the amount of forage production is decreased in proportion to the rockiness. The rockiness also makes cultivation of the more gently sloping areas very difficult or impractical Consequently, there is little or no use of this soil for dryfarmed barley or for hay. The rockiness does not prevent surface application of nitrogen fertilizer to improve forage yields. Rock outcrops, particularly where they occur in clusters, afford some protection for small wildlife. Capability unit VIs-8 (18); range site 3; natural land type E4; Storie index rating 28.

Cibo very rocky clay, 30 to 45 percent slopes (CvE).—Rock outcrops occupy from 10 to 25 percent of the surface area of this steep soil. In other respects this soil is similar to Cibo very rocky clay, 45 to 70 percent slopes. This soil is on Granite Hill, Campbell Mountain, and Tivy Mountain. It is also located on other ridges and hills northeast of Centerville and Round Mountain.

The steep slopes do not seriously reduce the intensity of grazing on this soil. The rockiness reduces forage production somewhat, but it provides some shelter for small wildlife. Forage production can be increased by applying nitrogen fertilizers, but the rockiness and the steep slopes make surface application of materials impractical in many places. Capability unit VIs-81 (18); range site 3; natural land type E12; Storie index rating 14.

Cibo extremely rocky clay, 3 to 30 percent slopes (CwD).—This undulating to hilly soil has more outcrops of rock on the surface than the soil described as typical for the series in this area. The surface area occupied by outcrops ranges from about 25 to 50 percent, but in most areas it is about 35 percent. The distribution of outcrops is not always uniform within any area of the soil.

This soil is well drained. Runoff is medium to rapid after the soil swells and the surface cracks close The hazard of erosion is variable, ranging from slight to moderate, depending on the outcrops.

This soil is mainly on the less steep slopes of foothill outliers such as Round Mountain, Jesse Morrow Mountain, Smith Mountain, and Granite Hill Included with this soil in mapping were some small areas having less than 25 percent rockiness.

This soil is fair for grazing. The growth of forage

is considerably reduced in proportion to the amount of rock outcrops. The rockiness also makes it impractical to apply fertilizer to the surface. Areas of this soil provide many protective sites for small wildlife. Capability unit VIIs–7 (17, 18); range site 3; natural land type E4; Storie index rating 19.

Cibo extremely rocky clay, 30 to 45 percent slopes (CwE).—This soil is similar to Cibo very rocky clay, 45 to 70 percent slopes, but is rockier and not so steep. Rock outcrops make up 25 to 50 percent of the surface area, but in most areas they make up no more than about 35 percent. The distribution of outcrops is not always uniform. Drainage is somewhat excessive. Runoff is variable but normally rapid after the soil is wet and the cracks have closed. The hazard of erosion is moderate to high.

Areas of this soil are all south of the Kings River on the steep slopes of the prominent outliers along the edge of the foothills.

This soil is only fair for grazing. The rockiness makes it impractical to apply fertilizers to the surface. Capability unit VIIs–7 (17, 18); range site 3; natural land type E12; Storie index rating 10.

Coarsegold Series

The Coarsegold series consists of moderately deep or deep, well drained or somewhat excessively drained soils that formed from quartz mica schist. These soils have a thick, moderately fine textured, moderately permeable subsoil. They are typically on steep hills and ridges in the upper foothills.

The largest area of these soils is located in the vicinity of Watts and Burrough Valleys. Other areas are west of Kerckhoff Lake and south of Auberry on Black Mountain. South of the Kings River, areas of these soils lie near Dunlap and also on the White Deer Creek drainage. The soils are mainly at elevations between 1,600 and 3,600 feet. Some areas, however, lie as low as 750 feet in the deep canyon of the San Joaquin River, and others are as high as 3,800 feet on prominent hills or ridges. According to elevation, the average annual precipitation ranges from 23 to 30 inches; the average annual temperature from 61° to 58° F.; and the average growing season from 150 to 200 days.

The natural vegetation consists mainly of grass and trees, but there is a denser cover of woody plants on some north-facing slopes. The nonwoody plants consist of annual grasses and forbs. In woodland, blue oak is the dominant hardwood, but there is some interior live oak. A scattering of Digger pine grows on the soils north of the Kings River. Common shrubs are Mariposa manzanita, wedgeleaf ceanothus, mountain-mahogany, and poison-oak.

In a typical profile, the surface layer is brown, slightly acid fine sandy loam about 8 inches thick. The surface layer overlies a reddish brown, slightly acid light clay loam subsoil about 30 inches thick. The subsoil fingers irregularly into well weathered quartz mica schist. Angular fragments of parent rock and aplitic or quartz dike rocks are common in most places.

Coarsegold soils are used for range and generally are well suited to that use. They comprise important parts of small watersheds. Water for livestock comes from many short intermittent streams and a few perennial streams. Small dams are built across some intermittent streams to store some of the runoff. There is little deep percolation of surface water into the underlying unweathered rock. Rainwater is absorbed by the soil to its capacity, and the excess runs off. Springs are not common in areas of these soils. Many forms of wildlife seek refuge in the more densely wooded areas.

Representative profile in rangeland, on a southeast slope of about 43 percent at an elevation of 1,200 feet, under an open stand of blue oak and Digger pine and ground cover of annual grasses and forbs (about 3½ miles, airline, NE. of Trimmer on the W. side of Old Wagon Road in Big Creek Canyon about 400 feet E. of the N. quarter-corner of the SE¼ sec. 33, T. 11 S., R. 25 E.):

O1—Very thin, patchy litter of grasses and forbs.

A11—0 to 3 inches, brown (7.5YR 5/3) fine sandy loam, dark brown (7.5YR 3/2) when moist; weak, fine granular structure; slightly hard when dry, friable when moist; nonsticky and nonplastic when wet; abundant fine and very fine roots; occasional fragments of parent rock and quartz vein rock; slightly acid (pH 6.3); abrupt, smooth lower boundary.

A12—3 to 8 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 3/4) when moist; massive breaking to medium subangular blocky structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; plentiful fine and very fine roots; common fine and very fine tubular pores; many microsize interstitial pores; occasional angular fragments of parent rock and quartz vein rock; slightly acid (pH 6.1); clear, wavy lower boundary.

B21t—8 to 18 inches, brown to reddish-brown (5–7.5YR 5/4) light clay loam, dark reddish brown (5YR 3/4) when moist; moderate, fine, subangular blocky structure; hard when dry, firm to friable when moist, slightly sticky and slightly plastic when wet; few fine and very fine roots; common fine and very fine tubular pores; many thin clay films on ped and pore faces; occasional angular fragments of parent rock and quartz vein rock; slightly acid (pH 6.1); clear, wavy lower boundary.

B22t—18 to 32 inches, reddish brown (5YR 4/4) light clay loam, yellowish red (5YR 4/6) when moist; moderate, medium, angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; few fine and very fine tubular pores; dense; many moderately thick clay films on ped faces; occasional angular fragments of quartz vein rock; slightly acid (pH 6.3); diffuse, broken lower boundary.

B2&C—32 to 52 inches, deep tonguing of material from B22t horizon into fractured and well-weathered, steeply dipping layers of C horizon.

C—52 inches +, brownish-yellow to yellowish-red, well-weathered quartz mica schist with a coarse network of fine quartz veins; many microsize intergrain pores; grades to unweathered rock within a few feet.

The color of the A11 horizon is normally brown but ranges in hue from 10YR to 7.5YR. On some northern slopes, the color darkens to grayish brown (10YR 5/2). The moist color has a hue of 7.5YR and a value-chroma combination of 3/2 or 3/4. The B horizon is normally reddish brown but is dark red to yellowish red in places (5YR 4/4, 5/4, 5/6; 2.5YR 3/6). In places, the upper part of the B horizon is strong brown or brown (7.5YR 5/6, 5/4) with reddish-brown clay coatings. The moist color is generally dark reddish brown

but in places is dark red or yellowish red (5YR 3/3, 3/4, 4/6, 5/6, 2.5YR 3/6).

The texture of the A horizon is mainly fine sandy loam but is very fine sandy loam or loam in places. Structure is granular or subangular blocky in the upper part of the A horizon, unless the soil has been trampled heavily by grazing animals. The lower part of the A horizon is normally massive. The texture of the B horizon is clay loam or fine sandy clay loam. Structure of the B horizon is commonly moderately blocky or subangular blocky, though it is prismatic in places.

The consistence is hard to very hard when dry, and very firm or firm to friable when moist. When the B horizon is wet, it is sticky or slightly sticky and slightly plastic. The profile is mainly slightly acid throughout. In some places the surface layer is neutral, and the lower subsoil is moderately acid (pH 6.0). In many areas the B22t horizon has a less irregular lower boundary than that described as typical.

The depth of soil material to weathered rock is generally more than 36 inches. On some very steep slopes, however, it ranges from about 20 to 36 inches.

Coarsegold fine sandy loam, 45 to 70 percent slopes (CxF).—This very steep soil occupies prominent ridges and is free of rock outcrops. It is evenly covered with annual grasses and forbs. Blue oak is openly scattered over most south-facing slopes, but it is in somewhat more dense stands in draws and drainageways. North facing slopes have a more dense cover of oak, including some live oak. Some shrubs and Digger pine also invade north slopes.

The general drainage is somewhat excessive. Subsoil permeability is moderately slow, runoff is rapid, and the erosion hazard is high. The available water holding capacity is typically moderate, but it is low in areas where the soil depth is less than 30 inches.

The largest areas of this soil are near Dunlap and in the vicinity of Watts Valley and Burrough Valley.

On the White Deer Creek watershed, a similar soil of minor extent has been included with this soil in mapping. The included soil has a clay subsoil that is redder and more slowly permeable than the typical one. The soil supports a denser cover of woody plants than this Coarsegold soil.

This soil is used mainly for range. It produces a good growth of forage for livestock. The slopes, however, reduce the intensity of use. During the green-forage season in spring, while the soils are still moist and soft, cattle will range rather widely on the very steep slopes and graze much of the available forage. As the soil dries out and the surface hardens, the intensity of use diminishes and the cattle tend to graze elsewhere or concentrate on footslopes, which they often overgraze. Stock trails, fencing, and planned location of salt licks help to gain a longer season of more uniform grazing of the soils. Forage on this soil responds to fertilizing with nitrogen, phosphorus, and sulfur, but the steep slopes and the difficulty of getting full utilization of available forage make it impractical to fertilize. Capability unit VIIe-1 (18); range site 1; natural land type E9; Storie index rating 13.

Coarsegold fine sandy loam, 9 to 15 percent slopes (CxC).—This soil is similar to Coarsegold fine sandy loam, 45 to 70 percent slopes, but is in areas of low, rolling hills in Burrough Valley, in Watts Valley, and in the vicinity of Ruth Hill east of Squaw Valley. This soil is well drained, runoff is medium, and erosion hazard is moderate. The available water holding capacity is moderate to high.

This soil is used for dryfarmed grain-hay or for improved dry pasture. Capability unit IIIe-8 (18); range site 1; natural land type E1; Storie index rating 59.

Coarsegold fine sandy loam, 15 to 30 percent slopes (CxD).—This soil is similar to Coarsegold fine sandy loam, 45 to 70 percent slopes, but is not so hilly. It is well drained. Runoff is medium to rapid, and the hazard of erosion is moderate to high. This soil is in small areas in and near Watts and Burrough Valleys, near Humphreys Station, and in the vicinity of Dunlap. In a few places the surface layer is loam.

Included with this soil in mapping were areas where there are occasional clusters of rock outcrops. Also included were a few areas where the surface layer is loam, and a small area, near White Deer Flat, of a similar soil that has a dark-red clay subsoil.

Coarsegold fine sandy loam, 15 to 30 percent slopes, is used only for grazing. It is well suited to this use and provides good growth of forage. Fertilization with nitrogen, phosphorus, and sulfur to increase production of forage is practical. However, some areas are isolated and associated with much steeper soils, and in these areas fertilization is not feasible. Capability unit IVe-8 (18); range site 1; natural land type E1; Storie index rating 51.

Coarsegold fine sandy loam, 30 to 45 percent slopes (CxE).—This soil occupies steep hills and ridges near Burrough Valley, Watts Valley, Auberry, and Dunlap. It has a profile similar to that of Coarsegold fine sandy loam, 45 to 70 percent slopes. Included with this soil in mapping was a small area of a similar soil north of Burrough Valley that has been severely gullied. Also included was a small area near White Deer Flat in which the subsoil is clayey and redder colored than the typical one. Natural drainage is somewhat excessive, runoff is rapid, and the hazard of erosion is high.

Coarsegold fine sandy loam, 30 to 45 percent slopes, is used for grazing and is well suited to this use. In places, clearing brush and trees would increase the area suitable for grazing. The slopes do not lessen the intensity of use by livestock. Fertilization of accessible areas of this soil in order to increase production of forage is practical. Capability unit VIe-8 (18); range site 1; natural land type E9; Storie index rating 19.

Coarsegold rocky fine sandy loam, 45 to 70 percent slopes (CyF).—This soil has about 2 to 10 percent of its surface area occupied by outcrops of parent rock. The profile is somewhat more stony or cobbly than that described as typical for the series, and the depth of soil to weathered rock is somewhat shallower, ranging from about 20 to 36 inches. The available water holding capacity is low because weathered rock is near the surface and fragments of rock are in the soil.

This soil occupies side slopes on the headwaters of Lefever Creek, along the canyon of White Deer Creek,

on the sides of Black Mountain, in the San Joaquin River canyon, and on the ridges near Watts Valley.

The soil is used for range. It is somewhat less productive than the nonrocky Coarsegold soils because of the rockiness and low water-holding capacity. Its slope reduces the intensity of its use. Capability unit VIIe-1(18); range site 1; natural land type E12; Storie index rating 8.

Colluvial land (CzF) consists of soil materials that have been moved downslope, either by a sudden landslip or by slow, mass flow when the materials were saturated. It is mainly in the foothills north of the Kings River, but some areas are near Tivy Mountain south of the river. This land type occurs in steep or very steep areas where soil materials weathered from basic igneous, metamorphic, or volcanic rocks. Slopes range from 3 to 50 percent, but in most places they are more than 30 percent.

The natural vegetation consists mainly of annual grasses and forbs, but some oaks and shrubs grow on slopes facing north and in protected areas.

This land type includes some soils that are moderately deep or deep and consist of mixed loam and clay loam soil material. Some areas are gravelly, some are nongravelly, but most are stony. These stony areas are shown on the soil map by a symbol. About 15 to 40 percent of the surface is covered by angular stones. The soil material has not been in place long enough for the formation of horizons that would permit classification in a series. This material overlies weathered bedrock or truncated parts of buried soils.

Colluvial land is well drained to somewhat excessively drained. Runoff ranges from medium to rapid, and the hazard of erosion ranges from slight on gentle slopes to very high on very steep slopes. The steeper areas normally are cut by deep drainageways.

All the acreage of Colluvial land is grazed, but some areas are so rough and broken by landslips that they provide little grazing. These rough broken areas provide a refuge for wildlife. Springs and seeps provide some water for livestock and wildlife, particularly quail. Capability unit VIIs-8 (18); range site 4; natural land type E12; Stories index rating 15.

Cometa Series

The soils of the Cometa series are brownish colored and have a subsoil of dense clay. They are well drained and are moderately deep over weakly cemented granitic sediments that were exposed to weathering by the normal erosion of old alluvial terraces.

These soils are undulating to rolling or hilly and are mainly in the eastern part of the San Joaquin Valley at elevations of 370 to 600 feet. The average annual rainfall ranges from about 12 to 14 inches; the average annual temperature is about 62° F.; and the growing season is about 250 days. The natural vegetation consists of annual grasses and forbs.

In a typical profile, the surface layer is light-brown sandy loam that is medium acid or slightly acid and about 17 inches thick. The subsoil is dense, brown, slightly acid clay that extends to a depth of about 26 inches. It is underlain by a weakly cemented, slightly acid, coarse sandy loam that extends to a depth of 60 inches or more.

The Cometa soils are used mainly for dryfarmed grain and as range. Some areas have been developed for orange groves, principally because they are in a zone of low frost hazard.

Representative profile on a west-facing slope of about 4 percent, in an undulating range pasture of annual grasses and forbs, at an elevation of 390 feet (4½ miles N. of Clovis; in a large trench in the NW¼NE¼NE¼ sec. 17, T. 12 S., R. 21 E. This site was subsequently destroyed by land leveling operations involving cuts of at least 5 feet):

O1—Very thin, discontinuous litter of dried grasses and forbs.

A11—0 to 8 inches, light-brown (7.5YR 6/4) sandy loam, brown to dark brown (7.5YR 4/4) when moist; massive; hard when dry, friable when moist, nonsticky and nonplastic when wet; plentiful fine and very fine roots; common fine tubular pores and many microsize interstitial pores; medium acid (pH 5.7); clear, wavy lower boundary.

A12—8 to 12 inches, light-brown (7.5YR 6/4) sandy loam with brown (7.5YR 5/4) staining on some sand grains giving weak salt and pepper appearance, dark brown (7.5YR 4/2-4/4) when moist; massive; hard when dry, friable when moist, nonsticky and nonplastic when wet; few fine roots; similar porosity to A11 horizon with few, thin clay coatings on some tubular pores; medium acid (pH 6.0); clear, wavy lower boundary.

A3—12 to 17 inches, light-brown (7.5YR 6/4) sandy loam, brown (7.5YR 5/4) clay films on many sand grains give an obvious salt-and-pepper appearance, reddish brown (5YR 4/3) when moist; massive to weak, coarse subangular blocky structure; hard when dry, friable when moist, slightly sticky when wet; very few fine roots, many fine and very fine tubular pores, many microsize interstitial pores, very thin clay films on some weak ped faces, some pore coatings; slightly acid (pH 6.5); abrupt, wavy lower boundary.

B2t—17 to 26 inches, brown (7.5YR 5/4) clay, dark reddish brown (5YR 3/3) when moist; strong, coarse, prismatic structure, tending toward columnar structure in places, breaking readily to strong, coarse, angular blocky structure when distributed; top ⅛ inch of prisms or columns has a very thin, bleached capping when dry; very hard when dry, firm when moist, sticky and plastic when wet; very few fine roots; common very fine random tubular pores; moderately thick to thick continuous clay films on ped faces; occasional slickensided fracture faces at about a 60 degree slant in the lower part of the horizon; slightly acid (pH 6.5); abrupt, wavy lower boundary.

C—26 to 60 inches +, varicolored light yellowish-brown and strong brown (10YR 6/4, 7.5YR 5/6, 5/8), compact coarse sandy loam, brown to strong brown (7.5YR 5/4, 5/6) when moist; massive; hard to very hard when dry, variably weakly cemented, widely spaced vertical seams filled with indurated colloidal silicate material, generally firm or brittle when moist, but friable in places; many microsize interstitial pores; slightly acid (pH 6.5); several feet thick.

The depth to the compact C horizon ranges from 20 to 40 inches but is commonly 24 to 30 inches. The color of the A horizon is commonly light brown or brown. The hue is 10YR or 7.5YR, the value is 5 or 6, and the chroma is 3 or 4. In places these colors are reddish brown (5YR 5/4). When moist, the A horizon is brown to dark brown (7.5YR 5/4, 4/4; 10YR 4/3) or, in some places, reddish brown (5YR 4/3). The texture ranges from sandy loam to loam. The A

horizon is typically massive, and when dry it is hard to very hard and broken with difficulty into large clods. The reaction ranges from slightly acid to moderately acid. The thickness of the A horizon ranges from about 10 to 18 inches.

The strongly developed B2t horizon ranges from 2 to 30 inches in thickness but commonly is 6 to 12 inches thick. The texture is clay or sandy clay. The color is brown, dark brown, or reddish brown (7.5YR 5/4, 4/4; 5YR 5/4) and reddish brown or dark reddish brown (5YR 5/4, 4/3, 3/3) when moist. The structure is weak to strong, prismatic or columnar, breaking to strong angular blocky. The pale-colored, dusted cappings on the prisms or columns are variable in their occurence and generally are not visible when the soil is moist. The B2t horizon is less acid than the A horizon. Normally, the B2t horizon is slightly acid to neutral but is mildly alkaline in places. In places, minor lime seams occur in the compact C horizon.

Cometa sandy loam, 3 to 9 percent slopes (CzaB).—A profile of this soil is described as typical for the series. This soil is generally well drained. Permeability is very slow; runoff is medium. In swales and on more gentle slopes, a perched zone of saturation generally develops above the dense subsoil during the rainy season or from uncontrolled irrigation water. The depth of the root zone is limited but not completely restricted by the dense subsoil. Although the total moisture-holding capacity is moderate to high, the storage of moisture available to plant roots is low to very low. The hazard of erosion is slight or moderate.

This soil is along most of the eastern edge of the San Joaquin Valley lands in Fresno County. The greater part is on dissected, low terraces north and east of Clovis. A few small areas are in some of the minor stream valleys in the lower foothills.

In the vicinity of Round Mountain and the community of Academy, several small areas that have slopes of less than 3 percent were included with this soil in mapping. In some places, small areas of San Joaquin, Ramona, and Hildreth soils are closely intermingled with this soil and were included. In some depressional areas there are minor inclusions of a similar soil having a surface layer that is darker than normal for the Cometa series. Also included were small, random spots of similar soil having a sandy clay loam subsoil.

Cometa sandy loam, 3 to 9 percent slopes, is used mainly for dryfarmed small grain, principally barley, and for annual range. Small areas associated with other deeper or more gently sloping soils are used for irrigated row crops or forage crops. Citrus groves have been established on this soil in recent years, mainly in the vicinity of Orange Cove.

When thoroughly dry, the massive surface layer is hard or very hard and is not easily tilled with light equipment. When slightly moist, it becomes remarkably friable and can be kept in good tilth. Small grains on this soil respond to additions of nitrogen and phosphorus. The quantity and quality of annual range grasses are improved greatly by the addition of nitrogen and phosphorus, provided adequate moisture is available. Legumes, either on the range or planted for forage, respond to applications of sulfur in the form of gypsum or through the use of superphosphate.

Because of the shallow effective rooting zone of this soil and the undulating relief, this soil is not well suited to irrigated crops other than pasture irrigated by sprinklers. For row crops or trees, well planned and costly ripping and land leveling or reshaping are necessary. Ripping deepens the rooting zone somewhat, but it does not completely remove the limitation of slow internal drainage. Careful management of irrigation water is necessary to avoid harmful saturation of the subsoil. Reshaped surfaces generally need renewal of fertility by building up the content of organic matter and by adding nitrogen and phosphorus fertilizers. Crops that bring high cash returns per acre, such as citrus crops, are needed to meet the costs of development and management of this soil for irrigated crops. A reliable supply of ground water is not available for all areas of this soil. Capability unit IVe–3 (17); range site 8; natural land type E5; Storie index rating 32.

Cometa sandy loam, 9 to 15 percent slopes (CzaC).—This soil occupies the sloping sides of minor stream valleys and the rolling areas of the dissected low terraces adjacent to these streams. In other respects this soil is similar to Cometa sandy loam, 3 to 9 percent slopes. It is in small areas north and west of Orange Cove, south of Friant, and along the lower part of Little Dry Creek in the foothills. Runoff is medium, and the erosion hazard is moderate to high.

This soil is used mainly for range, dry pasture, or dryfarmed small grain, principally barley. Because of the hazard of erosion, this soil is most suitable for range, dry pasture or pasture irrigated by sprinklers. Irrigated row crops and forage crops are poorly suited. Capability unit IVe–3 (17); range site 8; natural land type E5; Storie index rating 29.

Cometa sandy loam, 15 to 30 percent slopes (CzaD).—This soil is on moderately steep sides of minor stream valleys and dissected low terraces adjacent to these streams. In other respects this soil is similar to Cometa sandy loam, 3 to 9 percent slopes. Runoff is medium to rapid, and the erosion hazard is high.

This soil is used only for annual range or dry pasture, and it is well suited to these uses. It is not suited to row, tree, or forage crops. The fertility and the response of the natural forage to fertilizing are similar to those of Cometa sandy loam, 3 to 9 percent slopes. Capability unit VIe–3 (17); range site 8, natural land type E5; Storie index rating 22.

Cometa loam, 2 to 9 percent slopes (CzbB).—This soil is undulating to gently rolling. It is similar to Cometa sandy loam, 3 to 9 percent slopes, except in texture of the surface layer and slightly greater available water capacity. The clay subsoil is as thick as 2 to 2½ feet in some areas where the soil developed in dissected colluvial material adjacent to higher lying soils of the foothills. The subsoil of this soil overlies materials that vary somewhat in compaction and texture, ranging from weakly compacted, loamy material to moderately cemented sandy material. Runoff is slow to medium, and the erosion hazard is slight to moderate.

In the vicinity of Academy and Friant, small areas of similar soils having a surface layer of fine sandy loam and similar or slightly steeper slopes have been included with this soil in mapping. Near Navelencia

other small areas of a similar soil with slightly steeper slopes have been included, as well as a small area of Alamo clay.

Cometa loam, 2 to 9 percent slopes, is somewhat better suited to range and dryfarmed small grains than Cometa sandy loam, 3 to 9 percent slopes. The management and limitations of both soils for range, dryfarmed small grains, citrus crops, and other irrigated crops are similar. Capability unit IVe–3 (17); range site 8; natural land type E5; Storie index rating 34.

Cometa-San Joaquin sandy loams, 3 to 9 percent slopes (CzcB).—The soils of this complex are too closely intermingled to be mapped separately at the scale used in mapping. Cometa sandy loam is the dominant member of the complex, and its profile is similar to that described as typical for the series. The hardpan-bearing San Joaquin sandy loam makes up about 30 to 40 percent of the mapping unit. Its profile is similar to the profile described as typical under the San Joaquin series. The slopes are undulating, and San Joaquin soils occupy the knolls and crests of low ridges that are remnants of the original alluvial terraces. Clusters of low hummocks, or hogwallow mounds, are scattered throughout the complex, generally in areas of the San Joaquin soils. Runoff is medium; the erosion hazard is moderate.

Included with this complex in mapping were some small areas of Hildreth and Alamo clays in swales.

The use of the soils in this complex is about the same as that for Cometa sandy loam, 3 to 9 percent slopes. The management is also about the same but must take into account the hardpan that occurs in an irregular pattern within the mapping unit. The hardpan severely restricts internal drainage and root penetration. For this reason, attention is also directed to the discussion of the management of the San Joaquin soils. Capability unit IVe–3 (17); range site 9; natural land type E5; Storie index rating 30.

Delhi Series

The Delhi series consists of deep, somewhat excessively drained, rapidly permeable, coarse-textured soils formed in wind-laid deposits of uniformly sorted sandy material. The parent material was blown from recent granitic alluvium, carried short distances, and heaped into an undulating to gently rolling relief. Areas of this material are generally oriented parallel to the prevailing northwesterly winds.

Most areas of the Delhi soils are on the central part of the young fan of the Kings River. Some areas are near the foothills in the Navelencia district. These soils range in elevation from about 225 feet to 400 feet. Average annual precipitation ranges from 9 to 12 inches; average annual temperature is about 62° F.; and average growing season ranges from about 225 to 250 days.

Typically, the Delhi soils have a pale-brown, slightly acid loamy sand surface layer about 7 inches thick. The thick loamy sand layer beneath is similar to a depth of 60 inches or more. It is generally neutral or mildly alkaline and in many places is slightly yellowish in color.

The Delhi soils are too droughty for dryfarming. Nearly all of their acreage is irrigated, and most of it is used for vineyards. Some areas are used for field crops and melons. Peach and plum orchards are established in a few areas.

Representative profile in an undulating area in fallow on a north-facing slope of about 5 percent, under a sparse cover of annual grasses and forbs, at an elevation of 330 feet (about 3½ miles, NE. of Fowler; 700 feet E. and 40 feet N. of the intersection of America and Leonard Avenues in the SE¼SW¼SE¼ sec. 36, T. 14 S., R. 21 E.):

Ap—0 to 7 inches, pale-brown (10YR 6/3) loamy sand, dark grayish brown (10YR 4/2) when moist; single grain, soft to loose when dry, very friable when moist; plentiful fine roots; few fine tubular pores, abundant microsize and fine interstitial pores, slightly acid (pH 6.5); clear, smooth lower boundary.

C1—7 to 25 inches, pale-brown (10YR 6/3) loamy sand, dark brown (10YR 4/3) when moist; massive; soft when dry, very friable when moist, few fine roots; very few fine tubular pores, abundant microsize and fine interstitial pores; occasional thin fibers of clay accumulation, neutral (pH 7.0), diffuse, smooth lower boundary.

C2—25 to 60 inches, light yellowish-brown (10YR 6/4) loamy sand, dark yellowish brown (10YR 4/4) when moist; massive; soft when dry, very friable when moist; very few fine tubular pores, abundant microsize and fine interstitial pores, mildly alkaline (pH 7.5).

The A horizon is normally pale brown but in places ranges to brown, light yellowish brown, or light brownish gray. The hue is 10YR, and the values and chromas are 6/2, 6/3, 6/4, and 5/3. Moist colors are dark grayish brown or dark brown, and in some places dark yellowish brown (10YR 4/2, 4/3, 4/4). The A horizon is structureless, either single grain or massive. Dry consistence is soft or loose. The reaction ranges from slightly acid to neutral.

The C horizon is very similar to the A horizon in most respects, but it is generally slightly yellower in color in the lower part. This is shown by an increase of about 1 unit in chroma. The reaction ranges from neutral to mildly alkaline but it tends to be more alkaline with depth.

The Delhi soils generally have uniform texture throughout their profile. In most places they are sand or loamy sand. The soils are normally very deep, but in places they overlie an unrelated, compact silty layer at a depth of less than 4 feet.

Delhi loamy sand, 0 to 3 percent slopes (DhA).—The profile of this soil is very similar to that described as representative for the series. This soil is somewhat excessively drained, mainly because of its rapid permeability. Runoff is very slow, and the available water holding capacity is very low. The hazard of water erosion is very slight to none, but the hazard of soil blowing is slight to moderate.

This soil is distributed throughout the central and upper parts of the young fan of the Kings River in many wind-oriented areas of varying sizes. Except where it has been smoothed or leveled, the surface is gently undulating. Some areas of this soil are also on the flood plains of several small streams in or near the city of Fresno, the towns of Clovis and Reedley, and north of Sanger.

Included with this soil in mapping were small areas of Delhi sand, 0 to 3 percent slopes. Also included were small areas of Hanford sandy loam, Hanford fine

sandy loam, and Dello loamy sand. These soils are located in depressional areas surrounded by the somewhat higher lying Delhi loamy sand.

Raisin grapes, mainly Thompson seedless, are the principal crop grown on this soil. Fair to good yields of high-quality raisins are produced. In some years the grapes may be marketed fresh or sold to the wineries for crushing. Irrigation water is applied to the surface from gated outlets of a permanent system of pipes that supplies either irrigation district canal water or pumped ground water. Broad-based furrows having relatively short runs are used. During the vine season for raisins, four to eight irrigations are made. Most growers use nitrogen fertilizer either from commercial sources or from manure. Growing cover crops in alternate rows is commonly practiced during the winter months.

Alfalfa, corn, and cotton are also grown on this soil, as are some watermelons. Most crops respond to nitrogen and phosphorus. Nitrogen fertilizer is sometimes used to stimulate alfalfa seedlings. Cotton responds to potassium. Frequent irrigations are required to keep the root zone moist.

Peach and plum orchards on this soil are mainly remnants of more extensive tree fruit planting in the area years ago. Nematode infestations are more pronounced in coarse textured soil.

Winds in spring and early in summer may be intense enough to cause severe damage to emerging seedlings or young plants by blowing sand. Established vine rows present sufficient windbreaks to protect the soil from wind damage.

Pockets of cold air are trapped in some depressional areas. This presents a local frost hazard to budding grapevines in the spring. Capability unit IIIs-4 (17); range site not assigned; natural land type A5; Storie index rating 72.

Delhi loamy sand, 3 to 9 percent slopes (DhB).—This soil is similar to Delhi loamy sand, 0 to 3 percent slopes, but has an undulating to gently rolling, dune-like surface.

Included with this soil in mapping were small areas having slopes somewhat in excess of 9 percent. Also included, in the area of Fresno, were some areas having slopes of less than 3 percent.

Delhi loamy sand, 3 to 9 percent slopes, is used mainly for raisin grapes, but alfalfa, cotton, corn, and watermelons are also grown. The use and management of this soil are similar to those for Delhi loamy sand, 0 to 3 percent slopes. Surface irrigation for vineyards is by short runs, contour furrows, or minor terracing of the soil before establishment of the vines. Field crops are frequently irrigated by sprinklers. Windward slopes are subject to a greater hazard from soil blowing than leeward slopes. Capability unit IIIs-4 (17), range site not assigned; natural land type A5; Storie index rating 68.

Delhi loamy sand, moderately deep, 0 to 3 percent slopes (DlA).—The profile of this soil differs from that described as typical for the series in that it overlies unrelated, compact silty material at a depth of 2 to 4 feet. The material slows, but it does not seriously impede, downward movement of water. Root growth is somewhat checked; it is diverted to soil filled fractures or old burrows in the silty material.

The soil is mainly on the central and upper parts of the young fan of the Kings River. A few acres are located near Clovis and north of Sanger. In places the underlying material is at a depth in excess of 4 feet but less than 6 feet.

Included with this soil in mapping was a small area near Fowler in which the compact layer is a weakly cemented sandy material that impedes drainage more than that of the silty substratum typical of this soil.

Delhi loamy sand, moderately deep, 0 to 3 percent slopes, is used mainly for raisin grapes, but cotton, corn, alfalfa, and some watermelons are also grown. Use and management of this soil are similar to those for Delhi loamy sand, 0 to 3 percent slopes, but the silty layer underlying this soil holds more moisture available to the crop roots. Consequently, the period between irrigations can be extended somewhat. The silty material also supplied some plant nutrients to deeply probing roots. Capability unit IIIs-4 (17), range site not assigned; natural land type A6; Storie index rating 77.

Delhi sand, 0 to 3 percent slopes (DeA).—The profile of this soil is similar to that of Delhi loamy sand, 0 to 3 percent slopes, except that it consists of well-sorted sand composed mainly of subrounded medium and fine sand-size particles of feldspar and quartz. Drainage is excessive, and permeability is very rapid.

The available water holding capacity is about half that of the Delhi loamy sand. Because the surface layer is very loose and incoherent, this soil has a moderate or high hazard of blowing.

Included with this soil in mapping were some widely distributed, minor areas of a similar soil that overlies compact silty material at a depth of about 3 to 5 feet. The moisture-holding capability of the included soil is slightly higher than that for the typical soil.

Delhi sand, 0 to 3 percent slopes, is used almost entirely for growing raisin grapes. An excellent quality raisin is produced because of the high content of sugar formed in the grapes. This is ascribed to the more droughty soil in which the vine grows. The vine is not harmed, but the moisture stress is sufficient to cause more sugar to be accumulated in the grapes, compared to that in the grapes from similar vines grown on less droughty soils. The management is similar to that for Delhi loamy sand, 0 to 3 percent slopes. Capability unit IVs-4 (17); range site not assigned; natural land type A5; Storie index rating 51.

Delhi sand, 3 to 9 percent slopes (DeB).—The surface layer of this soil is pale brown to very pale brown, well-sorted sand. The underlying layers are similar sands but are light yellowish brown. This soil is similar to Delhi sand, 0 to 3 percent slopes, but is undulating to rolling. It is distributed over much of the young fan of the Kings River, including parts of the basin rim southwest of Kerman. A few small areas are located east and northeast of Reedley. In many places, areas of this soil have a bladelike outline; the long axis lies northwesterly, parallel to the

prevailing wind direction. Wind-scoured hollows generally lie within, or adjacent to, areas of this soil. These hollows are normally used as drainage ponds, are idle, or are used as unimproved pasture.

Included with this soil in mapping were a few small areas having slopes of more than 9 percent. These occupy slopes in the nearby hollows or the levee banks of former distributary channels of the Kings River near Parlier and Kingsburg.

The use and management of Delhi sand, 3 to 9 percent slopes, are similar to those of Delhi sand, 0 to 3 percent slopes. Most of the soil is used for raisin grapes, for reasons similar to those given for Delhi sand, 0 to 3 percent slopes. A much smaller acreage is used for field crops. Sprinklers are used to irrigate field crops. Contour furrows or very short straight run furrows are used in surface irrigation. Some areas of the soil adjacent to the pastured hollows are not cropped, and their sparse cover of annual grass and forbs is also grazed. Capability unit IVs-4 (17); range site not assigned; natural land type A5; Storie index rating 49.

Dello Series

The Dello series consists of deep soils that formed under somewhat poorly drained to poorly drained conditions from permeable, coarse-textured, granitic alluvium or wind-laid sands. These nearly level or very gently undulating soils occupy bottoms of wind-scoured hollows, segments of naturally dammed flood distributary channels, and parts of the river bottoms. In the past, when the water table was closer to the surface, the depressions in which these soils are located were intermittent ponds. With the development of surface irrigation water, many became perennial ponds when they were used as sumps for excess canal water. Some depressions continue to be used as sumps, but with the general lowering of the water table, the ponding is only intermittent. Others not used as sumps now have improved drainage.

The Dello soils are extensive and are widely distributed in relatively small areas on the young fan of the Kings River as far west as Caruthers. They are also located in the less well drained parts of the Sanger bottom lands, on the recent fan of the Kings River between Laton and Burrel, and on parts of the recent fan of the San Joaquin River north of Whites Bridge. The elevation ranges from about 160 feet to 400 feet. Average annual precipitation ranges from about 8 to 12 inches, the average annual temperature is about 62° F., and the frost-free season ranges from about 225 to 250 days. These soils occupy some pockets in which cold air is trapped, and therefore the frost hazard is somewhat greater during the winter and early in spring than in adjacent higher areas. The natural vegetation consists of annual grasses, herbs, sedges, saltgrass, and willows.

A typical profile has a surface layer of grayish-brown, moderately alkaline loamy sand about 8 inches thick. The surface layer overlies thick layers of light brownish gray, mottled, mildly to moderately alkaline loamy sand and sand extending to a depth of 60 inches or more.

Runoff from these soils is very slow or none because of their position and the permeability of the soil material. Locally, when the water table rises above the bottom of the depressions, ponds are formed. When the water table is low, the soils drain quickly, but they are still subject to seepage or overflow from surrounding, higher lying soils. If they are subject to drainage from surrounding soils, the loamy sands drain more readily than the sandy loam. In places, in the sandy loams there is a slight restriction of the downward movement of moisture where the surface layer meets the underlying coarse material.

Dello soils are used for field crops and vineyards where drainage has been improved.

Representative profile in a fallow field on the nearly level floor of a large wind-scoured hollow, at an elevation of about 270 feet (2 miles S. of Malaga; 200 feet E. and 50 feet S. of the intersection of Lincoln and Chestnut Avenues in the NW¼, sec. 7, T. 15 S., R. 21 E.):

Ap—0 to 8 inches, grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) when moist; surface has a weak crust; lightly sprinkled with clean light brownish gray (2.5Y 6/2) coarse sand after cultivation and elutriation by rains; single grain; loose when dry, very friable to loose when moist, nonsticky and nonplastic when wet; abundant fine roots, many very fine and microsize interstitial pores; considerable undecomposed organic matter; moderately alkaline (pH 8.0); abrupt, wavy lower boundary.

C1g—8 to 24 inches, light brownish-gray (2.5Y 6/2) loamy sand, dark grayish brown (2.5Y 4/2) when moist; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; few to very few fine to medium roots; common medium tubular pores, very few very fine tubular pores, all with strong brown (7.5YR 5/8) stains on their walls; many microsize interstitial pores; mildly alkaline (pH 7.5); gradual, smooth lower boundary.

C2g—24 to 36 inches, light brownish-gray (2.5Y 6/2) loamy sand, grayish brown (2.5Y 5/2) when moist; nonsticky and nonplastic when wet; common, fine, distinct mottles of yellowish brown; massive; slightly hard when dry, very friable when moist; few very fine roots, very few medium roots; few bundles of very fine roots in fine tubular pores; few fine to very fine tubular pores stained strong brown (7.5YR 5/8); many microsize interstitial pores; moderately alkaline (pH 8.0); diffuse, smooth lower boundary.

C3g—36 to 60 inches, light brownish-gray (2.5Y 6/2) sand, olive brown (2.5Y 4/4) when moist; common, fine, distinct mottles of yellowish brown; single grain; loose when dry or moist; no roots; many very fine and microsize interstitial pores; moderately alkaline (pH 8.0).

The A horizon is grayish brown to dark grayish brown (10YR 5/2, 2.5Y 5/2, 4/2) in some places and is light brownish gray to gray (10YR 6/2, 2.5Y 6/2, 5/1) in other places. Most colors are dark grayish brown to very dark grayish brown (2.5Y 4/2, 3/2) and, in places, dark brown to dark gray (10YR 3/3, N 4/0). Uncultivated areas show dark mottles in the A horizon. The C horizons are light brownish gray to light gray (2.5Y 6/2, 7/2). When moist they range from dark grayish brown or grayish brown to olive brown (2.5Y 4/2, 4/3, 4/4). They have distinct to prominent

mottles of yellowish brown or strong brown. Bluish colors are found where drainage remains poor.

In the wind-scoured hollows the texture of the A horizon is commonly loamy sand, but it is sand in places. Texture varies somewhat where stratification occurs, as in the remnant channels of old flood distributaries; typical loamy sand or sand is in places thinly layered with fine sandy loam, sandy loam, or silty material below a depth of 30 inches. Where the soils occupy graded former streamways, the A horizon is sandy loam or fine sandy loam, and it overlies a C horizon of sand. The sandy soils are without structure, and when dry they are either single grain and loose or massive and slightly hard. In the sandy loam soils the A horizon is either weakly granular or massive and slightly hard. Reaction of the A horizon ranges from slightly acid to moderately alkaline. Reaction of the C horizon ranges from neutral to moderately alkaline.

Dello loamy sand (0 to 2 percent slopes) (Dm).—A profile of this soil is described as typical for the series. The soil is widely scattered in small areas over much of the young fan of the Kings River in the vicinity of Del Rey and Parlier, and in the region to the west. Most of these areas occupy the bottoms of wind-scoured hollows. The soil formed in either coarse, stratified alluvium exposed by wind scouring or in more uniform, wind-worked sand.

Small areas of a similar soil having a slight to moderate amount of lime in the underlying material were included with this soil in mapping.

Most of the acreage of Dello loamy sand has altered drainage and is now moderately well drained. Permeability of the drained areas is very rapid. Some slightly more sloping areas are adjacent to, or surround, the lower parts of those depressions used as sumps for excess canal water. This water percolates eventually into the ground water. The available water capacity is low. The soil blowing is a slight but continuing hazard to unprotected areas, particularly during the months late in spring and early in summer.

Under irrigation, this soil is used to grow cotton, corn, grain sorghum, alfalfa, irrigated pasture, and some grapes. The natural fertility of this soil is fair, but when first cultivated it is generally somewhat better than that of adjoining Delhi soils. The relative difference, however, disappears in a few seasons of cropping. Fertilization with nitrogen and phosphorus is needed to produce a fair to good growth of field crops. Frequent irrigation is required to maintain adequate moisture in the root zone. Strong wind during the seedling stage of field crops can cause widespread damage to the crop by blowing sand that destroys many seedlings. Windbreaks of trees or vineyards help to reduce the force of the wind. Irrigated pastures produce fair yields of forage; and vineyards, mainly of raisin grapes, produce fair yields of raisins or fresh fruit. The frost hazard for grapes at the time of early leaf budding, or setting of fruit clusters, is greater on this low-lying soil than on surrounding, higher lying soils. Undeveloped areas of this soil are used for pasture, commonly for dairy stock. Capability unit IIIw-4 (17); range site not assigned; natural land type A5-1p; Storie index rating 58.

Dello sandy loam (0 to 2 percent slopes) (Dn).—This soil is similar to Dello loamy sand, but has a sandy loam or fine sandy loam surface layer that ranges from about 10 to 15 inches in thickness. The surface layer lies abruptly on mottled, light-gray or light brownish-gray sand. In places the underlying material is stratified with loamy sand, but in most places it is not.

The surface layer of this soil holds somewhat more available water than the surface layer of Dello loamy sand. However, fewer roots penetrate below the surface layer of this soil and explore the sandy underlying material. The available water holding capacity of both soils is low.

Dello sandy loam is in many areas occupying segments of former river distributaries on the young fan of the Kings River, and in minor depressions or drainage swales on the recent fans of both rivers, and in the bottom lands east of Sanger.

In the bottom lands east of Sanger, a small area of a similar soil having a channeled microrelief was included with this soil in mapping.

Dello sandy loam is used principally for field crops, such as alfalfa, cotton, and corn, all of which respond to nitrogen and phosphorus fertilizers. Some areas of the soil are used for irrigated pasture, and the results are fairly good if the surface layer is not cut away during preparation of the soil. The underlying sand alone is too droughty for irrigated pasture. Capability unit IIIw-4 (17); range site not assigned; natural land type A1-1p. Storie index rating 65.

Delpiedra Series

The Delpiedra series consists of excessively drained, shallow, extremely stony, medium-textured soils that formed on weathered serpentine rock. The serpentine parent rock has undergone certain metamorphic processes that added calcium-bearing minerals to the rock.

These moderately extensive, steep to very steep soils are on prominent ridges in the central part of the foothills, mainly north of the Kings River. Most of the acreage in this area is mapped in complex with soils of the Fancher series. The Delpiedra soils are at elevations of 500 to 2,800 feet. According to elevation, average annual precipitation ranges from about 16 to 20 inches, and average annual temperature ranges from about 62° to 59° F. The growing season ranges from 175 to 200 days. The natural cover consists of annual grasses and forbs, and there are some clusters of perennial grasses on protected sites. At the higher elevations, some blue oak and wedgeleaf ceanothus grow on northerly slopes.

A typical profile of the Delpiedra soils has a reddish-brown, neutral extremely stony loam surface layer about 4 inches thick. The subsoil is yellowish-red, neutral gravelly loam about 8 inches thick. It fingers irregularly into weathered serpentine rock.

Delpiedra soils are used solely for grazing. Forage growth is fair, but it is unusually good for soils that formed on serpentine rock. Local water sources are limited to a few springs and to the flow of short, intermittent streams late in winter and in spring.

Representative profile on a south-facing slope of about 55 percent, in an area of rangeland at an ele-

vation of 1,100 feet under a cover of annual grasses and forbs and some clumps of perennial grasses (5¾ miles, airline, NE. of Piedra on the N. side of Trimmer Springs Road near the center of SE¼ sec. 24, T. 12S., R. 24 E.):

A1—0 to 4 inches, reddish-brown (5YR 5/4) loam, dark reddish brown (5YR 3/4) when moist; weak medium to fine subangular blocky structure; hard when dry, friable when moist, slightly plastic and slightly sticky but with a slick feel when wet; abundant fine roots; common fine tubular pores; many angular serpentine rock fragments; neutral (pH [illegible]); abrupt, irregular lower boundary.

B2t—4 to 12 inches, yellowish-red (5YR 4/6) heavy gravelly loam, dark reddish brown (2.5YR 3/4) when moist; strong medium to fine subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many thin clay films on ped faces and in pores; abundant fine roots; common fine tubular pores; many angular serpentine rock fragments; neutral (pH 7.0); abrupt, irregular lower boundary.

C—12 to 20 inches, mass of weathered serpentine rock fabric of which the fragmented fragments are hard when dry but can be partly crushed in the hand when moist; few fine roots and reddish clay films on fracture surfaces in upper part; grades abruptly and very irregularly into greenish gray, unweathered but shattered serpentine parent rock.

The content of angular stones is variable. In general, stones occupy from 3 to 15 percent of the surface area. In places the soil is gravelly or cobbly. Outcrops of parent rock are few and far between. The color of the A1 horizon is commonly reddish brown (5YR 5/4) but is yellowish red (5YR 5/8) in places. When moist the A horizon is generally dark reddish brown (5YR 3/4) but ranges to reddish brown (5YR 4/4). The structure ranges from weak subangular blocky to granular, but in places the horizon is massive. Consistence is hard or slightly hard when dry. When wet the soil has a slick or greasy feel. The reaction of the A horizon [illegible] slightly acid [illegible].

The B horizon is redder than the A horizon, ranging from dark reddish brown to yellowish red or reddish brown (2.5YR 3/4, 3/6, 5YR 4/6). When moist it is dark reddish brown (2.5YR 3/4, 5YR 3/4). The texture ranges from heavy loam to clay loam. The structure ranges from weak to strong subangular blocky. In places the B horizon has a slick or greasy feel from talc. This horizon is generally neutral but in some places it is mildly alkaline. The solum ranges from about 10 to 20 inches in thickness.

Delpiedra extremely stony loam, 45 to 70 percent slopes (DpF).—The soil is excessively drained, mainly because it is shallow and steep. Runoff is very rapid after saturation of the soil material. The field capacity of the soil ranges from very low to medium. Permeability is moderate. Some deep percolation of excess water is afforded by the highly fractured parent rock. The available water holding capacity is very low to low depending on depth of the soil. The hazard of erosion is high. This very steep soil is subject to landslips and considerable soil creep. Evidence of this movement is seen in several old landslide scars and in the low, rippling undulation of the steep surface. The steeply dipping fracture planes of the bedrock and the slick-sided nature of the rock fragments help to lower the stability of this soil when it is saturated.

This soil occupies prominent ridges. Some areas lie west of Piedra and east of Humphreys Station. Additional areas of this soil lie east of the survey area on a continuation of the serpentine rock ridges north of Pine Flat Reservoir.

This soil is used only for range. This is a good use, though the range is only fair. The soil also has value for wildlife habitat and as a watershed area. The steep slopes reduce the intensity of use by grazing animals. Development of stock trails and suitable placement of salt licks to encourage wider ranging of livestock would assist in better utilization of the forage. The soil is low in nitrogen, but the steepness precludes economic fertilization of the soil. Capability unit VIIs–8 (18); range site 9; natural land type E16–4p; Storie index rating 5.

Delpiedra extremely stony loam, 30 to 45 percent slopes (DpE).—This soil has a profile similar to that described as representative of the series. It is in several areas widely scattered on hills and ridges around the periphery of the serpentine rock ridges north of the Kings River. The areas are generally detached from the main body of serpentine rock.

Runoff is rapid, and the hazard of erosion is high. This soil is used only for range. It is less productive of forage than other closely associated soils used for range soils in the foothills. However, fertilization can improve the yield of forage. The grasses respond well to nitrogen but are less responsive to phosphorus and sulfur.

Studies have shown that poor growth of plants on "serpentine soils" can be attributed to a high level of magnesium and a low level of calcium in these soils. Applications of gypsum give marked improvement in growth. However, an increase in forage growth on Delpiedra soils through the application of calcium in the form of gypsum is uncertain. Analyses show that Delpiedra soil contains less calcium than magnesium but has a greater content of calcium than many other soils derived from serpentine rock. This can be attributed to the calcium-bearing minerals added to the local rock by metamorphic processes. The level of calcium in the soil is at a point where, according to greenhouse studies, further addition of calcium produces little or no significant increase in plant growth. Capability unit VIs–9 (18); range site 9; natural land type E16–4p; Storie index rating 11.

Delpiedra-Fancher extremely stony loams, 45 to 70 percent slopes (DsF).—This mapping unit consists of two soils too closely intermingled to be mapped separately at the scale used. They are of about equal proportion in the complex. The unit is extensive and occupies most of the very steep serpentine ridges in the foothills north of the Kings River. The profile of the Delpiedra soil is similar to that described as typical for the series. The Fancher extremely stony loam component, also formed from serpentine rock, has a soil profile similar to that described as typical under the Fancher series. Fancher soils are moderately deep, reddish colored, and neutral, and they have a slowly permeable clay subsoil.

Runoff is very rapid after saturation of the soils. The average field capacity is moderate to medium. The average available water holding capacity is low or moderate. The available water holding capacity for

the Fancher soil is much greater than that for the Delpiedra soil. The hazard of erosion is very high. The soils are susceptible to landslips.

These soils are used for range, but they are some of the less productive range soils. The management is similar to that of Delpiedra extremely stony loam, 45 to 70 percent slopes. Capability unit VIIs-8 (18); range site 9, natural land types E16-4p and E12-4p. Storie index rating 5.

El Peco Series

The El Peco series consists of medium-textured or moderately coarse textured, calcareous soils that formed under somewhat poorly drained conditions. These soils are moderately deep to a strongly cemented lime-silica hardpan. They are commonly saline-alkali affected and developed in granitic alluvium in the basin rim zone of the young fans of both the San Joaquin River and Kings River. These soils are mainly nearly level, but there is some slight hummocky microrelief in areas that have not been leveled.

The soils are located within a broad, irregular belt from near Caruthers northwesterly to the vicinity of Kerman. They are also in small areas north of Riverdale and Laton. They are at elevations of 175 to 275 feet. The average annual precipitation is about 8 inches, the average annual temperature is about 63° F., and the average growing season is 225 to 250 days. The natural vegetation consists of annual grasses and forbs and plants tolerant of salt and alkali.

Typically the El Peco soils have a pale-brown, moderately alkaline, calcareous fine sandy loam surface layer about 10 inches thick. The surface layer overlies a light-gray to pale-yellow, very strongly alkaline, calcareous layer of fine sandy loam that occurs abruptly on a strongly cemented lime-silica hardpan at a depth of about 23 inches. The hardpan is about 10 inches thick. Uncemented silt and more permeable, but generally saline-alkali, loamy or sandy material lies beneath the hardpan.

In their natural condition, El Peco soils are used for winter and spring range. Irrigation water of good quality can be pumped from moderately shallow wells. The water table lies at a depth of about 50 feet but is subject to some fluctuation. If these soils are irrigated and reclaimed, they are used for irrigated pasture and field crops.

Representative profile on a nearly level slope, at an elevation of about 260 feet, in native pasture supporting sparse cover of annual grasses and saline-alkali-tolerant plants (3¾ miles, airline, NE. of Laton, 3/8 mile S. and 200 feet W. of intersection of Davis and Highland Avenues in the NE¼SE¼NE¼ sec. 12, T. 17 S., R. 21 E.):

A11—0 to 1/2 inch, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; moderate, fine platy structure, soft when dry, friable when moist, nonsticky and nonplastic when wet; abundant very fine roots; many very fine interstitial pores; slightly calcareous with disseminated lime; mildly alkaline (pH 7.8); abrupt, smooth lower boundary.

A12ca—1/2 inch to 10 inches, pale brown (10YR 6/3) fine sandy loam, dark brown (10YR 4/3) when moist, massive, slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; plentiful very fine roots; many very fine and few fine tubular pores, many microsize interstitial pores, strongly calcareous with disseminated lime, moderately alkaline (pH 8.3), clear, smooth lower boundary.

C1ca—10 to 23 inches, pale-yellow (2.5Y 7/3) fine sandy loam, light olive brown (2.5Y 5/3) when moist, massive, slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; occasional very fine roots; few very fine tubular pores and many microsize irregular pores; strongly calcareous with disseminated carbonates, strongly alkaline (pH 8.5), very abrupt smooth lower boundary.

IIC2mca—23 to 33 inches, light brownish-gray (2.5Y 6/2) strongly cemented lime-silica hardpan, dark grayish brown (2.5Y 4/2) when moist, coarse platy to massive, occasionally fractured; strongly calcareous from disseminated lime and lime in seams and crusts, dense, very slowly permeable; gradual, smooth lower boundary.

IIC3—33 inches +, light brownish-gray and light-gray (2.5Y 6/2, 7/2) stratified silt and silt loam, dark grayish brown (2.5Y 4/2) when moist; massive, uncemented, hard when dry, friable to firm when moist, slightly sticky and slightly plastic when wet; variably calcareous from disseminated lime, and some lime segregated in threads and thin seams; moderately alkaline (pH 8.3).

The color of the A horizon, exclusive of the thin A11 horizon, ranges from light brownish gray to light gray. The hue is 10YR or 2.5Y in places, and the value and chroma are 6/2, 6/3, or 7/2. When moist, the color darkens to grayish brown or dark brown. The hue and chroma remain the same, but the value is only 4 or 5. The A horizon is generally massive, but in places it is platy or vesicular in scald spots (these are surface areas strongly saline-alkali affected and devoid of vegetation). Consistence ranges from slightly hard to hard. Reaction ranges from moderately alkaline to strongly alkaline. The thin A11 horizon is missing where the soil has been cultivated or where scald spots occur. Where the A11 horizon is present, it ranges in thickness from about 1/2 to 1 inch. The thickness of the A horizon ranges from 6 to 12 inches.

The color of the C horizon, including the hardpan, is similar to that of the A horizon, but generally it has a slightly more yellow appearance. The hue is 10YR or 2.5Y, the value is 6 or 7, and the chroma is 2 or 3. Moist colors darken to brown, dark brown, or grayish brown. The hue remains the same, but value and chroma are 5/3, 4/3, or 5/2. The uncemented C horizon is typically massive and ranges in dry consistence from slightly hard to hard. The reaction ranges from strongly alkaline to very strongly alkaline, except where reclaimed, in which case the reaction is moderately alkaline.

The typical depth to the hardpan is 23 or 24 inches, but depth commonly ranges within short distance from about 18 to 36 inches. The degree of lime-silica cementation is variable, but it generally decreases with depth. A thin, white crust of cementing agents caps the surface of the pan in some places. Yellowish or reddish mottles appear in places. In many places the hardpan consists of a series of thin indurated layers, 1 to 2 inches thick, separated by uncemented silty or loamy material. In places the first indurated layer is below a thin, uncemented layer of firm, light-gray silt. The uncemented material is variably saline-alkali affected.

El Peco fine sandy loam (0 to 2 percent slopes) (Ed).—This soil has the profile that is representative of the series. Except where it is reclaimed, this soil is saline-alkali affected below a depth of about 10 to 12 inches. In many areas parts of the surface layer

are similarly affected, and this is indicated by scald spots, or areas of markedly depressed plant growth separated by apparently unaffected areas of the soil. From one area to another, the proportion of the surface layer visibly affected ranges from none to more than two-thirds of the total area. Affected parts of the soil are strongly or very strongly alkaline and are at least slightly saline from an accumulation of neutral and basic salts.

Runoff on El Peco fine sandy loam is slow. In natural areas, water is generally ponded locally in minor swales. The permeability is very slow because of the hardpan. Normally, the surface layer that is unaffected by saline-alkali conditions is not thick. Thus, the available water holding capacity is very low because of the limited depth of root growth. This is improved with reclamation. The hazard of erosion is slight or none. Some soil blowing occurs on scald spots or clean tilled areas.

Included with this soil in mapping were areas that have been reclaimed from excess salts and alkali. Also included were small areas where the depth to hardpan is as little as 6 inches or as much as 60 inches.

In its native condition, El Peco fine sandy loam is idle or used only for winter and spring grazing as an alkali pasture. If it is irrigated and reclaimed, this soil is fairly well suited to such field crops as cotton, corn, grain sorghum, alfalfa, sugar beets, and irrigated pasture. With the continued development of the basin-rim lands, much of this soil will be reclaimed and profitably used. For a discussion of the methods of reclamation see the section "Saline and Saline-Alkali Soils." The crops respond well to nitrogen and phosphorus fertilizers. Capability unit IIIs-6 (17); range site not assigned; natural land type B13-2s; Storie index rating 23.

El Peco loam (0 to 2 percent slopes) (Ep).—The loam surface layer and subsurface layer distinguish the profile of this soil from that described as typical for the series. The soil is in several areas west and northwest of Raisin City and north of Burrel. The surface layer of this soil is more extensively affected by excess salts and alkali than that of the El Peco fine sandy loam. Even so, much of the soil has been partially reclaimed. In its natural state, many tiny playas, 10 to 20 feet in diameter, are scattered throughout areas of the soil. The available water holding capacity is low or very low depending on depth to the hardpan and the degree of saline-alkali reclamation.

In its natural state, this soil is idle or used only for winter and spring grazing as an alkali pasture. If it is irrigated and reclaimed, it is fairly well suited to irrigated pasture and to such field crops as cotton, corn, barley, grain sorghum, and sugar beets. The use and management of this soil are similar to those for El Peco fine sandy loam. Reclamation is feasible but not effected so quickly. Capability unit IIIs-6 (17); range site not assigned; natural land type B13-2s; Storie index rating 23.

El Peco sandy loam (0 to 2 percent slopes) (Ec).—The profile of this soil is similar to that described as typical for the series, but it has a sandy loam surface layer and subsurface layer above the hardpan. Where this soil is used as an alkali pasture, there is little difference between this soil and El Peco fine sandy loam. After reclamation, which is feasible, the textural differences are important in management of irrigation water. The available water holding capacity is somewhat lower than that for El Peco fine sandy loam.

Some areas of El Peco sandy loam have been reclaimed or partially reclaimed and are used for irrigated pasture, alfalfa, and cotton. Growth is good where the soil is completely reclaimed within the rooting zone. Capability unit IIIs-6 (17); range site not assigned; natural land type B13-2s; Storie index rating 22.

Exeter Series

The Exeter series consists of well-drained soils having a medium-textured, weakly defined subsoil that overlies a strongly cemented silica-iron hardpan at a moderate depth. These soils developed in granitic alluvium of intermediate aged terraces of the Kings River and San Joaquin River, as well as those of smaller streams draining the foothills. Most areas of the soils are under cultivation and have a smooth, nearly level surface. Under natural conditions, these soils had a slightly hummocky microrelief.

Exeter soils occur in areas of different sizes throughout much of the eastern half of the San Joaquin Valley. They are at elevations of 200 to 450 feet. The average annual precipitation ranges from 9 to 14 inches, and the average annual temperature is about 62° F. The frost-free season ranges from 225 days to 275 days. Areas closer to the edge of the foothills have a longer growing season than others. The natural vegetation consists of annual grasses and forbs.

A typical profile has a surface layer of brown or light yellowish brown sandy loam about 15 inches thick. This is underlain by a brown or yellowish brown sandy loam subsoil that is mildly alkaline and slightly finer textured extending to a depth of about 30 inches. Below the subsoil is a dense strongly cemented silica hardpan of sandy material. The sandy material is stained reddish or brownish with iron oxides.

After the hardpan has been shattered and the soils smoothed or leveled, the soils are used for orchards, vineyards, and field crops. Irrigation water is imported through ditches or canals of irrigation district systems or is pumped from moderately deep wells.

Representative profile in a nearly level vineyard at an elevation of 355 feet (about 2 miles NE. of Parlier; about 100 feet W. of Smith Avenue and the E. quarter-corner of the SE¼SE¼ sec. 7, T. 15 S., R. 23 E.):

Ap—0 to 5 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) when moist; massive, broken to medium and coarse clods, hard when dry, friable when moist, nonsticky and nonplastic when wet; few fine and very fine roots; many very fine and microsize interstitial pores; neutral (pH 6.9); abrupt wavy lower boundary.

A3—5 to 15 inches, light yellowish brown (10YR 6/4) sandy loam, dark brown (7.5YR 4/4) when moist, mas-

sive, hard when dry, friable when moist, nonsticky and nonplastic when wet; few fine and very fine roots; common fine and very fine tubular pores, many very fine and microsize interstitial pores; neutral (pH 7.1); abrupt, wavy lower boundary.

B2t 15 to 30 inches, brown (10YR 5/3) heavy sandy loam, dark brown (7.5YR 4/4) when moist; weak medium to coarse, angular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine and very fine roots, very few medium roots; common fine and very fine tubular pores, common very fine and microsize interstitial pores; thin clay films as bridgings, grain coatings, and pore coatings; mildly alkaline (pH 7.4); very abrupt, wavy lower boundary.

Cm 30 inches +, varicolored hardpan, reddish to yellowish brown with dark gray splotches, strongly cemented, generally massive with a tendency toward a coarse platy structure in the upper part reflecting a sequence of horizontal seams of silica cementing material, some of which carry dendritic surface patterns from manganese dioxide deposits; mat of abundant fine and very fine roots on the upper surface of the pan; occasional vertical cracks have faces coated with the silica cementing material and are penetrated by a few roots; grades at about 33 inches into dense, weakly cemented brownish sandy material several feet thick.

The Ap and A1 horizons are commonly brown (10YR 5/3), but in places they are pale brown or brown (10YR 6/3; 7.5YR 5/4). When moist, they are dark brown (10YR 4/3; 7.5YR 4/4). The color of the A3 horizon is similar, but in places it has a light yellowish-brown (10YR 6/4) appearance. It is indistinguishable from the A horizon when moist. The texture of the Ap and A3 horizons are sandy loam, fine sandy loam, or loam. These horizons are massive or cloddy and range from neutral to slightly acid in reaction. The B horizon is brown, yellowish brown, or light yellowish brown (10YR 5/3, 5/4, 6/4). When moist, it is brown or dark brown (7.5YR 5/4, 4/4) with a tendency toward reddish brown in places. The B horizon is slightly finer textured than the A horizon. It has a weak, blocky structure or is massive and is neutral to moderately alkaline.

The depth to hardpan ranges from about 18 to 36 inches. The A horizon generally has a hard consistency when dry but is very hard in places from excess surface traffic or local puddling. During the rainy season or under irrigation, the soil above can become saturated quickly and puddle easily unless the hardpan has been shattered by deep ripping. The hardpan is typically strongly cemented to indurated but in places it is only weakly cemented and lacks the distinct horizontal layers of the main cementing agent. It ranges in thickness from 4 to 12 inches. In some places the hardpan has minor lime seams. The dense massive sandy material beneath the strongly cemented hardpan ranges from a few inches to as much as 10 feet in thickness. It lies abruptly on light-gray compact silt and fine sand. In places the sandy material is missing, and the hardpan has developed in the compacted silty material.

Exeter sandy loam (Es).—The profile of this soil, except for the sandy loam surface layer, is generally similar to that described for the series. In addition, the depth to the hardpan is generally more than 24 inches, except where land leveling has skimmed away part of the surface layer.

This soil is widely distributed over the alluvial terraces of the San Joaquin River. It is also located, but not so extensively, on terraces of the Kings River and of other smaller streams.

Permeability is very slow because of the hardpan. Runoff for the most part is medium, but is ponded in swales of areas that have hummocky microrelief. Under natural conditions, there is generally seasonal saturation of the subsoil above the hardpan. Breaks or cracks in the hardpan permit the perched water to drain away slowly, but nevertheless quickly enough to avoid the development of poor drainage in the subsoil. The seasonal saturation of the subsoil is generally in winter or early in spring when plant growth is limited. Therefore, it has little adverse effect on the shallow-rooted natural cover. The available water holding capacity of the soil is low, and the erosion hazard is slight.

This soil is used for many kinds of crops. Figs, peaches, plums, and oranges are grown. Oranges are restricted to an area close to the foothills where the frost hazard is at a minimum. Alfalfa and cotton are also grown, and excellent irrigated pastures have been established. Alfalfa is less successful than cotton. The management of all irrigated crops on this soil must take into account the presence and effect of the hardpan. Normally, the hardpan is ripped and shattered to deepen the soil and to speed its internal drainage. Ripping of the hardpan does not completely correct the slow internal drainage because of the compact, slowly permeable layers that lie just below the hardpan and extend to a depth below the reach of the blades. Most of the fig trees were planted after blasting the hardpan with dynamite. For most crops, the amount of irrigation water applied at any time should be controlled to avoid the building up of saturated layers in the subsoil, which can damage or impair root growth. Figs are an exception to this, but they are heavily irrigated during dormancy. Fertilization with nitrogen and phosphorus is required for good growth of any crop. Nitrogen alone is used for figs. Cotton responds to potassium. Capability unit IIIs-8 (17); range site not assigned; natural land type C18; Storie index rating 42.

Exeter sandy loam, shallow (0 to 2 percent slopes) (Et).—The profile of this soil is similar to that described as typical for the series, but it is shallower to the hardpan. The thickness of soil above the hardpan generally ranges from 12 to 20 inches, but in places it is as little as 8 inches. In some places, the depth to the hardpan is more than 20 inches. Many areas of this soil are naturally shallow, but some have been included that were thinned by land smoothing or leveling. Where the soil has been ripped to deepen or improve internal drainage, it generally contains many angular hardpan fragments the size of cobblestones or gravel. In many areas these must be removed in order to facilitate subsequent cultivation. The available water holding capacity is very low.

Most of the acreage is in the general vicinity of Fresno. Some areas lie near Navelencia. These and a few other areas near Fresno are inclusions of similar soils having a loam surface layer.

The use and management of Exeter sandy loam, shallow is similar to those of Exeter sandy loam. However, preparing this shallower soil for cropping requires a greater investment. Peaches and plums are normally not planted on this soil. Irrigation must be more frequent in order to maintain optimum moisture conditions. In addition, greater care is needed to avoid overirrigating. Capability unit IIIs-8 (17); range site

not assigned; natural land type C13; Storie index rating 29.

Exeter loam (0 to 2 percent slopes) (Ex).—The profile of this soil is similar to that described as typical for the series, but it is somewhat finer textured. The subsoil is fine sandy loam or loam. This soil is widely distributed on the alluvial terrace lands from Reedley to Herndon. It has a slightly higher available water capacity than Exeter sandy loam. Included in mapping were small areas of fine sandy loam.

The use and management of this soil are very similar to those of Exeter sandy loam. Capability unit IIIs-8 (17); range site not assigned; natural land type C13; Storie index rating 45.

Fallbrook Series

The Fallbrook series consists of well-drained to somewhat excessively drained soils that are moderately deep to weathered rock. These soils have a well-developed subsoil. They formed in place from the weathering of quartz diorite that has a moderate content of dark minerals, principally pyroxenes and biotite. The topography ranges from undulating land to very steep ridges, but it is typically hills and in many places is studded with irregularly shaped outcrops of parent rock.

These soils are in the lower foothills in several large separate areas from the vicinity of Friant to the Tulare County line. They are mainly at elevations of 500 to 1,500 feet, but in some places on a few prominent hills south of Squaw Valley they are as high as 2,000 feet. A few small areas are at even higher elevations on warm, open exposures of salient ridges southwest of the Miramonte Conservation Camp. According to elevation, average annual rainfall ranges from 14 to 18 inches and average annual temperature from 62° to 59° F. The growing season ranges from about 200 days to 250 days. The natural vegetation consists of annual grasses and forbs, as well as open, uneven-aged stands of blue oak. The oak is absent at the lower elevations.

The surface layer is typically brown, neutral to slightly acid sandy loam about 7 inches thick. The subsoil is mainly reddish-brown and brown sandy clay loam that is blocky and grades irregularly into well-weathered quartz diorite at about 29 inches.

Water sources are limited in the area of these soils. Water for domestic use and for livestock is obtained from springs, intermittent small streams, and some wells that tap water stored in deeply weathered rock. Many of the small streams are blocked by earthen dams to retain some of the runoff in ponds for livestock and for recreational use. Sufficient water for irrigated commercial crops is generally not available locally.

The Fallbrook soils are used almost entirely for range. Some small nonrocky areas having gentle slopes are used for dryfarmed barley or grain-hay production. With expansion of irrigation district systems, some of the lower lying areas of these soils that have gentle slopes are favorably located, climatically, and are suitable for citrus crops.

Representative profile in a natural area of hilly rangeland on a west-facing slope of 25 percent, at an elevation of 1,015 feet, in an open stand of blue oaks and interior live oaks having good ground cover of annual grasses and forbs. (S. of Squaw Valley on the E. side of Sand Creek Road, approximately ½ mile S. of its junction with Ennis Road in the SE¼SW¼ sec. 25, T. 14 S., R. 25 E.):

O1—Very thin litter of dried and partly decomposed parts of annual grasses and forbs.

A11—0 to 3 inches, brown (7.5YR 5/4) sandy loam, dark brown (7.5YR 3/4) when moist; nonsticky and nonplastic when wet; moderate, medium, granular structure; slightly hard when dry, friable when moist; abundant very fine roots; many very fine and few fine interstitial pores, many worm holes; neutral (pH 7.0); abrupt, smooth lower boundary.

A12—3 to 7 inches, sandy loam similar in color to A11 horizon; massive; hard when dry, friable when moist; nonsticky and nonplastic when wet; abundant very fine roots; occasional coarse roots; few fine and very fine tubular pores, many microsize interstitial pores, many worm holes; slightly acid (pH 6.5); clear, smooth lower boundary.

B1—7 to 11 inches, heavy sandy loam similar in color to A11 and A12 horizons; massive; very hard when dry; friable when moist, very slightly sticky and nonplastic when wet; plentiful very fine roots, occasional coarse roots, few very fine and fine tubular pores; many worm holes; slightly acid (pH 6.5); clear, smooth lower boundary.

B21t—11 to 20 inches, reddish-brown (5YR 4/3) sandy clay loam, dark reddish brown (5YR 3/3) when moist; strong, medium, angular blocky structure; very hard when dry, firm when moist, slightly sticky and slightly plastic when wet; plentiful very fine roots, occasional coarse roots; many very fine and few fine tubular pores; moderately thick, continuous clay films on ped faces and in pores; slightly acid (pH 6.3); clear, smooth lower boundary.

B22t—20 to 29 inches, brown (7.5YR 5/4 and 4/4) sandy clay loam, dark reddish brown (5YR 3/3) when moist; massive to very weak coarse blocky structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; roots and pores similar to those in B21t horizon, moderately thick to thin, continuous clay films on ped faces and in pores, scattered fragments of weathered parent rock; slightly acid (pH 6.3); clear, irregular lower boundary.

C—29 inches +, weathered quartz diorite with reddish-brown clay films on fracture planes; grades variably with depth to unweathered parent rock.

The commonly brown (10YR 5/3; 7.5YR 5/4) dry color of the A11 and A12 horizons ranges to dark brown or strong brown in places (7.5YR 4/4, 5/6). On some northerly slopes, the colors tend toward grayish brown (7.5YR 5/2). Moist colors are dark brown (10YR 3/3, 7.5YR 3/4, 4/4) and in some places dark reddish brown (5YR 3/3). Where slight erosion has occurred, the A11 horizon is generally redder than it is in other places. The texture is commonly sandy loam but ranges to coarse sandy loam. The A11 and A12 horizons are hard and massive, except in protected areas where the surface layer is thin and granular. When moist, the A horizon is friable and appears to have a weakly granular structure if disturbed. The thickness of the A horizon ranges from about 6 to 14 inches.

The transition to the B2t horizon is generally clear and through a B1 horizon. Color of the B horizon is generally reddish brown (5YR 4/4, 5/4), although the B1 and lower B2t horizons are somewhat more brown (5-7.5YR 5/4 or 4/4) in places. When moist, the B horizon is dark reddish brown (5YR 3/3, 3/4); the B1 horizon is dark brown (7.5YR 3/4). Structure of the B2t horizons range from weak to strong blocky. Texture is commonly sandy clay loam or clay loam but ranges to heavy sandy loam in places.

The profile is from neutral to slightly acid. The solum

grades abruptly or clearly, with a wavy or irregular form, into the C horizon of weathered quartz diorite. The thickness of the solum ranges mainly from about 20 to 40 inches, but in places the solum is as thin as 12 inches. The C horizon grades to unweathered parent rock within a depth of as little as 3 feet to as much as 50 feet. Large unweathered, spheroidal boulders are generally enclosed in the groundmass of weathered rock and detached from the underlying unweathered rock.

A little more than half of the Fallbrook soils in this survey area have significant amounts of rock outcrops. Most of these rocky soils have less than 25 percent of the surface area occupied by outcrops, but some have between 25 and 50 percent of their surface area occupied.

Fallbrook very rocky sandy loam, 3 to 30 percent slopes (FcD).—The profile of this soil is very similar to that described as typical for the series. A large area is located in the foothills near Academy. This soil is also east of Friant, northeast of Round Mountain, and in the vicinities of Citrus Cove and Squaw Valley. From about 2 to 25 percent of the surface of each area of soil is occupied by subrounded, irregular rock masses that generally are prominent. Only a few are low-lying. The rock masses range in diameter from about 2 to 30 feet and stand 3 to 15 feet in height. Most occur singly, but some are grouped in clusters. They have a dull-colored or gray appearance from lichen growths. On lichen-free surfaces there is a slight rusty discoloration in many places.

This soil is well drained. The permeability of the subsoil is moderately slow. Runoff is medium to rapid and variable from place to place because of the rock outcrops. The available water holding capacity is low to moderate, and the erosion hazard is slight to high. In places outcrops provide a natural terracing effect, thereby protecting small areas of the soil.

Small areas of Vista and Sesame soils were included with this soil in mapping. In swales or along small watercourses, areas of Hanford, Visalia, Chualar, and Hildreth soils were also included.

This soil is used mainly for grazing, to which it is well suited. The surface rockiness makes tillage difficult or impractical. Fertilization with nitrogen, and possibly phosphorus for grasses, and sulfur to encourage legume growth, can greatly improve forage production during years of adequate rainfall. Fertilization also improves the palatability of forage. This soil constitutes significant parts of small watersheds in the foothills, and its rockiness affords some protective areas for small wildlife. The parent rock of this soil is quarried in the vicinity of Academy for dark granite monument or building stone. Capability unit VIs-1 (18), range site 6, natural land type E1; Storie index rating 37.

Fallbrook very rocky sandy loam, 30 to 70 percent slopes (FcF).—This soil is similar to Fallbrook very rocky sandy loam, 3 to 30 percent slopes, except that this soil is steep or very steep. In addition, the degree of rockiness on the very steep slopes ranges up to about 50 percent in some areas. Drainage is somewhat excessive. Runoff is rapid, and the hazard of erosion is high to very high.

This unit is located in several areas on prominent ridges and hills in the vicinity of Millerton Lake, Humphreys Station, Citrus Cove, Shannon Valley, and on exposed south-facing slopes southwest of Miramonte. The areas having slopes of less than 45 percent are located near Shannon Valley.

This soil is used for range, watersheds, and natural refuge sites for many forms of wildlife. The outcrops tend to diminish total forage production in proportion to the area occupied. This is less significant on the very steep slopes because the intensity of grazing is less there. Areas of this soil having slopes of less than 45 percent are somewhat more intensively grazed because less effort is required for the animals to move about. Stock trails and selected placement of salt licks can increase the utilization of available forage. Fertilization is not practical, because of the slopes and rockiness. Capability unit VIIs-8 (18), range site 6; natural land type E12; Storie index rating 9.

Fallbrook very rocky sandy loam, shallow, 3 to 30 percent slopes (FdD).—The profile of this soil is similar to Fallbrook very rocky sandy loam, 3 to 30 percent slopes, but is shallower to weathered parent rock. The average depth to parent rock is about 20 inches, but ranges from 12 to 24 inches. The surface layer is similar in thickness, but the subsoil is about one-half as thick as that typical for the series. This soil is more droughty than the deeper Fallbrook soils, and forage tends to dry up earlier in the season. The available water holding capacity is very low.

This undulating to hilly soil occupies rock-studded terrain in the lower foothills in the neighborhood of Academy and Round Mountain. Areas of the soil also lie west of Bear Mountain.

The chief use of this soil is for grazing. The management is similar to that of Fallbrook very rocky sandy loam, 3 to 30 percent slopes. Forage production is more responsive to the distribution of rainfall during the winter and spring months. With uniform distribution, forage production is similar to that on the deeper Fallbrook soils. With uneven distribution of rainfall or below normal rainfall and an early seasonal end to the periodic storms, forage production is lower. Under the latter conditions, fertilization response is limited, and fertilization may not be economical. Nitrogen applications may be lost, but gypsum can carry over with the chance of better rainfall distribution and amounts in the following year. Capability unit VIs-41 (18), range site 7; natural land type E8; Storie index rating 21.

Fallbrook very rocky sandy loam, shallow, 30 to 70 percent slopes (FdF).—The profile of this soil is shallower to weathered parent rock than Fallbrook very rocky sandy loam, 3 to 30 percent slopes, but is otherwise similar. The depth to weathered rock ranges from 12 to 24 inches but commonly is about 20 inches. About 20 percent of the total acreage has slopes ranging between 30 and 45 percent. The rest of the acreage has steeper slopes. The rockiness ranges from 2 to 25 percent on the less sloping areas and up to 50 percent in places on the very steep areas. Drainage is good to somewhat excessive, runoff is rapid to very rapid, and the hazard of erosion is high.

Areas of this soil occupy prominent hills and

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ridges near Owens Mountain, Humphreys Station, Academy, Millerton Lake, Citrus Cove, and on the lower Sand Creek drainage.

Included with this soil in mapping was a small area of a similar soil that is steep and not rocky. It occurs in several small areas east of Owens Mountain. Also included is a small area of similar, but eroded, soils in the hills north of Academy

This soil is used for range. It comprises significant parts of small watersheds and provides refuge sites for wildlife because of its many outcrops. Because of steep slopes and rockiness and the uncertainty of seasonal rainfall distribution, fertilization is impractical The very steep slopes are less intensely utilized by livestock. Stock trails, selected location of salt licks, and fencing may change the livestock grazing patterns so as to use more of the available forage. Capability unit VIIs-8 (18); range site 7; natural land type E16; Storie index rating 8.

Fallbrook extremely rocky sandy loam, 30 to 45 percent slopes (FeE).—This soil is similar to Fallbrook very rocky sandy loam, 3 to 30 percent slopes, but has a greater amount of surface rockiness and steeper slopes. Dark, irregularly shaped rock outcrops occupy from 25 to 50 percent of the surface of this soil. This soil is on steep prominent hills east of Academy.

The natural drainage is somewhat excessive. Runoff is rapid, and the hazard of erosion is high. The rockiness lowers the hazard of erosion somewhat by breaking up the runoff of moving surface water.

The rockiness significantly reduces the amount of forage production, making this soil less suited to range. Fertilization to improve forage yields is impractical. The rockiness, however, provides a good area for wildlife refuge, and the soil has value as a segment of small watersheds. Capability unit VIIs 7 (17, 18); range site 10; natural land type E12; Storie index rating 9

Fallbrook sandy loam, 3 to 9 percent slopes (FaB) This soil is similar to that described as typical for the series.

This undulating to gently rolling soil is free of rock outcrops and is located mainly along the lower edge of the foothills from Owens Mountain to Citrus Cove, and in Squaw Valley. Some small areas of the soil occupy low knolls surrounded by soils formed from valley fill material.

This soil is moderately slowly permeable but well drained. Runoff is medium, and the hazard of erosion is slight to moderate. Available water capacity is low to moderate

Included with this soil in mapping were some small areas of a similar soil having a loam surface layer. The included soil is in Tivy Valley, Clarke Valley, and near Round Mountain.

This soil is used mainly for grazing and is suitable for dry pasture Fertilization with nitrogen, phosphorus, and sulfur to improve forage growth and palatibility is feasible and practical. Some areas are used for dryfarmed barley or grain-hay production. Many areas of this soil are favorably located in the thermal belt of minimum frost hazard and are suitable for citrus crops if reliable sources of irrigation water can be made available. Capability unit IIIe-8 (18); range site 6; natural land type E1; Storie index rating 54

Fallbrook sandy loam, 9 to 15 percent slopes (FaC).—This soil is similar to that described as typical for the series. All areas of this soil, however, are free of rock outcrops. The soil occupies rolling terrain in the lower foothills from Owens Mountain to Squaw Valley

This soil is well drained. Runoff is medium and the erosion hazard is moderate. The available water capacity is low to moderate.

Included with this soil in mapping was a small area of similar soils having a loam surface layer. The included soils are located near Tivy Valley

The use and management of this soil are similar to those for Fallbrook sandy loam, 3 to 9 percent slopes. If the soil is cultivated, tillage should be across the slope or on the contour to minimize losses from erosion This soil comprises the lower parts of many small watersheds. Capability unit IVe-8 (18); range site 6; natural land type E1; Storie Index rating 51

Fallbrook sandy loam, 15 to 30 percent slopes (FaD).—This soil is similar to that described as typical for the series. It is hilly and free of rock outcrops. The soil is well drained Runoff is medium to rapid, and the hazard of erosion is moderate to high. The available water capacity is low to moderate. This soil is distributed throughout the lower foothills from Millerton Lake to Squaw Valley.

The hilly terrain of this soil discourages cultivation for dryfarmed crops The soil provides good grazing, and fertilization to improve forage growth and palatibility is practical. The soil is an important part of small watershed systems. Capability unit VIe-1 (17, 18); range site 6; natural land type E1; Storie index rating 45.

Fallbrook sandy loam, 30 to 45 percent slopes (FaE).—This soil is similar to that described as typical for the series. All areas are free of rock outcrops. The soil occupies steep hills and ridges near Owens Mountain and Academy. The natural drainage is somewhat excessive, runoff is rapid, and the erosion hazard is high The available water capacity is low to moderate

This soil is used only for range and is suited to that use. The slopes are not too steep for efficient grazing The forage responds well to fertilization, but the effort and cost required to spread the materials in relation to economic return make this impractical Capability unit VIIe-1 (18); range site 6; natural land type E9, Storie index rating 23.

Fallbrook sandy loam, shallow, 3 to 9 percent slopes (FbB).—The profile of this soil is similar to that described as typical for the series but it is free of rock outcrops and only 12 to 24 inches thick over weathered rock This soil is well drained. Runoff is medium, and the erosion hazard is moderate. The available water capacity is very low

This undulating to gently rolling soil is along the lower edge of the foothills that emerge from the Great Valley alluvial fill lying to the west. Some areas of

the soil are on low knolls surrounded by other soils formed in the valley fill material.

Because of the shallowness, little of this soil has been cultivated for dryfarmed barley or grain hay. This soil is used mainly for grazing. Much of the soil is located in a zone of minimum frost hazard, but the shallowness and lack of irrigation water have deterred development for citrus crops. Capability unit IVe-4 (18); range site 7; natural land type E5; Storie index rating 31.

Fallbrook sandy loam, shallow, 9 to 30 percent slopes (FbD).—The profile of this soil differs from that described as typical for the series because it is only 12 to 24 inches to weathered rock. The soil is free of rock outcrops. It is well drained, runoff is rapid, and the erosion hazard is high. Areas of this rolling or hilly soil are along the lower edges of the foothills in the vicinity of Academy.

This soil is used for grazing. It is not suitable for cultivated crops. Capability unit VIe-41 (18); range site 7; natural land type E5; Storie index rating 27.

Fancher Series

The Fancher series consists of well-drained to somewhat excessively drained soils with a fine-textured, slowly permeable subsoil. These soils are moderately deep over altered serpentine rock. The parent rock contains some calcium-bearing minerals not generally associated with normal serpentine. The soils are steep to very steep, and they occupy prominent ridges that are separated by narrow, deeply incised, small canyons that are connected to form a complex dendritic drainage pattern.

These soils are in the central part of the foothill region; nearly all of the acreage is north of the Kings River. The soils are at elevations of 600 to 3,000 feet. The higher elevations mark salient ridges exposed to warm air currents from the lower San Joaquin Valley. The average annual precipitation ranges from 16 to 20 inches. The average annual temperature decreases with elevation from about 62° to 57° F. The average growing season ranges from 180 to 220 days.

The natural vegetation consists mainly of annual grasses and forbs with some clusters of perennial needlegrass. At higher elevations, mainly on protected slopes, there is a cover of grasses and shrubs, or trees, grasses, and shrubs. The woodland cover consists of blue oak; the shrub cover is mainly wedgeleaf ceanothus.

Typically, the Fancher soils have a reddish-brown, neutral extremely stony loam surface layer about 7 inches thick. The subsoil is mainly reddish-brown, medium acid gravelly clay and brown very gravelly clay loam. It grades irregularly into highly fractured, weathered serpentine rock at a depth of about 25 inches. The surface is extremely stony.

The Fancher soils are used for range. They produce a fair amount of forage, even though they were derived from serpentine rock. The fertility of these "serpentine soils" is discussed under the Delpiedra series. The Fancher soils are also important in that they comprise the entire watershed of many small streams. Near Piedra, the altered serpentine rock is quarried for road-building material.

Representative profile on a southeast-facing slope of 50 percent at an elevation of 2,000 feet, under annual grasses and forbs in rangeland having a semi-open cover of chaparral. Stones range from 1 to 2 feet in diameter and occupy 2 to 15 percent of the surface area (3½ miles, airline WSW. of Trimmer on the W. side of the Hog Mountain truck trail in SW¼SW¼ sec. 9, T. 12 S., R. 24 E.):

O1—½ to 0 inch, litter consisting of parts of dried annual grasses and forbs and some shrub leaves.

A11—0 to 2 inches, reddish-brown (5YR 5/4) extremely stony loam, dark reddish brown (5YR 3/4) when moist; moderate, fine granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant fine roots; many very fine interstitial pores; neutral (pH 6.6); abrupt, wavy lower boundary.

A12—2 to 7 inches, reddish-brown (5YR 4/4) extremely stony loam, dark reddish brown (5YR 3/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful fine roots; common medium tubular pores, occasional fragments of serpentine, neutral (pH 6.8); clear, wavy lower boundary.

B1t—7 to 12 inches, reddish-brown (5YR 4/4) gravelly loam, dark reddish brown (5YR 3/4) when moist, massive to very weak medium blocky structure, hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few medium and fine roots, common medium tubular pores; few to common thin clay films on ped faces, continuous thin clay films in pores; pebbles are angular fragments of parent rocks, neutral (pH 6.7); abrupt, irregular lower boundary.

B2t—12 to 20 inches, reddish brown (2.5YR 4/4) gravelly clay, dark reddish brown (2.5YR 3/4) when moist, strong, fine blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; few fine roots, few fine tubular pores, continuous moderately thick clay films on ped faces and in pores, pebbles are angular fragments of parent rock, medium acid (pH 6.0), abrupt, wavy lower boundary.

B3t—20 to 25 inches, brown (7.5YR 5/4) very gravelly clay loam, dark brown (7.5YR 3/4) when moist, moderate fine blocky structure, very hard when dry, friable when moist, sticky and plastic when wet, few fine roots, few fine tubular pores; many moderately thick clay films on ped faces and in pores, pebbles are angular fragments of parent rock, slightly acid (pH 6.5), abrupt, broken lower boundary.

C—25 inches +, highly fractured and moderately weathered serpentine parent rock, which crushes readily to a gravelly, loamy material, varied colors of green, white, yellow, and red, soil material from the B3t horizon tongues along fractures, and clay films coat some of weathered fragments; plentiful fine to medium roots follow the soil-filled cracks; grades to unweathered but fractured bedrock at about 50 inches.

This profile is generally gravelly or cobbly and commonly stony. Rock outcrops are uncommon. Where outcrops occur, they are low and unobtrusive. The colors of the A horizon do not vary greatly. The A horizon is reddish brown when dry but ranges between 2.5YR 4/4 and 5YR 5/4 or 4/4. When moist, it is dark reddish brown and ranges from 2.5YR 3/4 or 5YR 3/3 to 3/4. The A horizon is neutral or slightly acid. It is commonly massive but where it is pro-

tected from trampling by grazing animals, a thin granular surface horizon 2 to 4 inches thick forms.

The B horizon is generally redder than the A horizon. It ranges from reddish brown to dark reddish brown (2.5YR 4/4 or 3/4) when dry and dark reddish brown to dark red (2.5YR 4/4 or 3/4) when moist. Texture of the A horizon ranges from gravelly to extremely stony loam and gravelly to extremely stony clay loam. Texture of the B2t horizon is clay or gravelly clay. Structure is generally strong and angular blocky. The transitional (B1t) horizon does not occur consistently. Where this horizon is absent, the boundary of the A and B2t horizons is clear or gradual. The reaction of the B horizon generally is neutral to medium acid, but it is mildly alkaline in places. The transition to the parent rock is either abrupt or grades through a thin B3 horizon and a C horizon. The B3 horizon is brown (7.5YR 5/4) or light reddish brown (5YR 6/4 or 2.5YR 6/4) when dry and dark brown (7.5YR 3/4) to dark reddish brown (5YR 3/4, 2.5YR 3/4) when moist. The B3 horizon ranges from very gravelly clay loam to very gravelly loam. The C horizon is also very gravelly and is structureless loam. It has varied greenish to yellowish colors inherited from the parent rock. The thickness of the solum is variable within short distances; it ranges from about 15 to 36 inches, but is commonly greater than 20 inches.

Fancher extremely stony loam, 45 to 70 percent slopes (FhF).—This soil has a profile that is very similar to that described as typical for the series. This very steep soil occupies prominent ridges located mainly between Piedra, Humphreys Station, and Watts Valley. The soil is somewhat excessively drained. Subsoil permeability is slow, and runoff is rapid. Consequently, the erosion hazard is high. In very wet years, the soil is subject to landslips. Soil creep downslope is more common than in most other soils on uplands. The available water holding capacity ranges from medium to high, depending on depth of soil.

Combined with this soil in mapping was a moderately extensive acreage of similar soils having stony clay loam surface layers. Much deeper but otherwise similar soils formed in colluvial accumulations on foot slopes were also included. Also included were small areas of pale colored soils having a less strongly developed subsoil. The latter formed in material weathered from serpentine rock and are located in contact areas where the serpentine rock meets other kinds of rock.

This soil is used only for range. The forage production is fair, but the very steep slopes reduce the intensity of use by livestock. Suitable placement of stock trails and salt blocks can improve the grazing intensity. Forage growth increases with application of nitrogen fertilizers, but the steepness, difficult accessibility, and low intensity of grazing make application of fertilizer uneconomical. The soil contributes much runoff to local streams. Because access is commonly difficult, there is a minimum of disturbance by man. Hence, the soil has value as a refuge for many forms of wildlife that prefer open grassy areas. Capability unit VIIe-8 (18); range site 9; natural land type E12–4p; Storie index rating 6.

Fancher extremely stony loam, 30 to 45 percent slopes (FhE).—This soil is similar to Fancher extremely stony loam, 45 to 70 percent slopes. This soil is well drained to somewhat excessively drained. Runoff is rapid and the erosion hazard is high. Areas of this steep soil occupy hills and ridges near Watts Valley, northeast of Round Mountain, and in the vicinity of Piedra. They are also located on the lower north slopes of Tivy Mountain.

Included with this soil in mapping were several small areas of a similar soil having slopes of less than 30 percent and a small area of a similar soil having a stony clay loam surface layer.

This soil is used for grazing. The less steep slopes encourage greater use of forage by livestock than on the steeper Fancher soils. Fertilization with nitrogen is feasible but difficult. The natural presence of scattered perennial grasses on this soil and the good available water holding capacity suggest that protected slopes may provide reasonably good sites for Harding grass to improve the forage-producing capability of the soil. Capability unit VIe-9 (18); range site 9; natural land type E12–4p; Storie index rating 12.

Fancher-Blasingame complex, 30 to 45 percent slopes (FlE).—This complex consists of Fancher extremely stony loam and Blasingame loam so intermingled in small areas on steep ridges that it was impractical to separate the soils at the scale used in mapping. Each of the two kinds of soils makes up at least 20 percent of any given area mapped, but the proportions vary from place to place. The general pattern is one of a discontinuous, irregular band of the soils, reflecting the intrusion of serpentine dikes into basic schist rocks along the northern part of the serpentine rock area. The pattern is further complicated by the subsequent erosional dissection that formed the present ridged relief.

The profile of the Fancher soil in the complex is essentially similar to that described as typical for the Fancher series. The profile of the Blasingame soil is similar to that described as typical for the Blasingame series.

The complex is located on the headwaters of both Fancher and Hughes Creeks. The vegetation consists of trees, grasses, and shrubs, but the woody cover is somewhat denser than typical for either soil elsewhere. Less wedgeleaf ceanothus and more blue oak grow on the Blasingame soils than on the Fancher soils.

This complex is used mainly for range. It also is important as watershed and as wildlife habitat. The woody vegetation reduces the amount of forage available for grazing. Increasing the forage by controlled burning would be difficult and hazardous because access to critical parts of this complex is difficult. These parts lie adjacent to very steep brushland that should not be burned. Capability unit VIe-9 (18); range site 9; natural land types E12–4p and E9; Storie index rating 18.

Fancher-Blasingame complex, 45 to 70 percent slopes (FlF).—In this complex, Fancher extremely stony loam and Blasingame loam are so closely intermingled on ridges that it was not practical to separate them at the scale used in mapping. Each of the soils comprises at least 20 percent of any given area, but the proportions vary from place to place. The general pattern of this complex is one of discontinuous

banding of the soils. The profile of each soil in this complex is similar to those described as typical for each series.

Included with this unit in mapping were areas of Blasingame soils having a fine sandy loam surface layer.

This complex is used for range, wildlife, and as a watershed area. In addition to low forage production because of the woody vegetation, the steep slopes reduce the intensity of grazing on these soils. Where it is practical, stock trails can be developed to give easier access for livestock to parts of the complex. Capability unit VIIs-8 (18); range site 9; natural land types E12-4p and E9; Storie index rating 9.

Foster Series

The Foster series consists of deep, grayish-colored soils that formed in recent granitic alluvium under poorly drained conditions. The soils are nearly level and occupy slightly depressed positions on the lower parts of the recent fan of the Kings River. They also occupy depressed parts of recent flood plains along small streams in the eastern part of the San Joaquin Valley. The general drainage of most areas of these soils has now been improved through extensive lowering of the regional water table by pumping for irrigation, and by control of the main rivers and streams in the survey area. In places, Foster soils are saline-alkali affected.

The soils are at elevations ranging from 190 to 600 feet. The average annual rainfall ranges from 8 to 15 inches; the average annual temperature is about 62° F. The average growing season is about 225 days on the lower parts of the Kings River fan but ranges from about 250 to 275 days near the foothills. The depressed positions of the soils make them probable sites for local frost pockets.

A typical profile has a gray and light-gray sandy loam surface layer, about 16 inches thick, that is mildly or moderately alkaline. This layer overlies light-gray and light olive-gray, mottled, moderately alkaline, calcareous sandy loam that can be variable and stratified with coarse-textured material below a depth of about 30 inches.

Foster soils are used for many kinds of field crops and for irrigated pasture. Saline-alkali affected soils must be reclaimed to obtain good production.

Representative profile in a fallow field in a gentle depression, at an elevation of 204 feet (8 miles N. of Burrel; 800 feet W., 60 feet N. of the center of the intersection of Kamm and Jameson Avenues in the SE¼SE¼SE¼ sec. 15, T. 16 S., R. 18 E.):

Ap—0 to 9 inches, gray (10YR 5/1) sandy loam; occasional fine, prominent mottles of strong brown, very dark gray (10YR 3/1) when moist; nonsticky and nonplastic when wet; cloddy, slightly hard when dry, friable when moist; plentiful fine and very fine roots, common fine tubular pores, many microsize interstitial pores; mildly alkaline (pH 7.5); abrupt, wavy lower boundary.

A12—9 to 16 inches, light-gray (10YR 7/2) sandy loam, grayish brown (2.5Y 5/2) streaks along former root channels, dark grayish brown (2.5Y 4/2) when moist, massive, slightly hard when dry, friable when moist, very slightly sticky and nonplastic when wet; few fine and very fine roots; common very fine tubular pores and many microsize interstitial pores, few thin clay films in pores, slightly calcareous with lime segregated in many fine threads; moderately alkaline (pH 8.0); gradual, wavy lower boundary.

C1—16 to 30 inches, light-gray (2.5Y 7/2) sandy loam with few, fine, distinct mottles of light olive brown and few, fine prominent mottles of yellowish brown, grayish brown (2.5Y 5/2) when moist, massive, slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; no roots; few very fine tubular pores, many very fine and microsize interstitial pores, slightly calcareous with lime segregated into many fine threads, moderately alkaline (pH 8.0); diffuse, wavy lower boundary.

IIC2g—30 to 60 inches, light olive-gray (5Y 6/2) loamy sand with few, yellowish-brown stained sand grains, olive gray (5Y 4/2) when moist, massive; slightly hard when dry, very friable when moist, no roots; very few very fine tubular pores, many very fine and microsize interstitial pores; moderately alkaline (pH 8.0).

The texture of the A horizon ranges from loam to sandy loam. The A11 or Ap horizons in cultivated areas are dark gray, dark grayish brown, or gray. The hue is 10YR or 2.5Y and a value-chroma combination of 4/1 (dark gray), 4/2 (dark grayish brown), or 5/1. When the soil is moist, the value is 3 in most places but is 2 in some. There is little or no change in chroma, making the color very dark gray, very dark grayish brown, and in some places very dark brown or black.

The A12 horizon has hues and chromas similar to those of the Ap horizon, but the value is generally one unit higher. Thus the color is grayish brown, gray, or light gray when dry and dark gray or dark grayish brown when moist. The C horizons have a hue ranging from 10YR to 5Y, a value generally of 6 or more, and a chroma of 2. The color is gray or light gray, light brownish gray, or light olive gray. When the soil is moist, there is little or no change in chroma, but value is only 4 or 5, and the color appears to be grayish brown to dark grayish brown. Distinct or prominent mottles of various sizes and shapes are normally present in the A12 and C horizons. Mottle colors are grayish brown, brown, yellowish brown, or yellowish red.

Lime is disseminated or is weakly segregated in seams or threads, which generally follow old root channels. The A11 or Ap horizons are calcareous in some places. The A horizon ranges from neutral to moderately alkaline. The C horizons are mildly to moderately alkaline. Where saline-alkali affected, the soil reaction is strongly to very strongly alkaline. The A11 or Ap horizons are granular, massive or cloddy in places; the A12 and C horizons are generally massive. Dry consistence for all horizons is slightly hard or soft. The soil is normally very deep, but in places it overlies an unrelated, dense, weakly cemented sandy substratum at a depth ranging from about 24 to 40 inches. The C1 horizon is sandy loam or loam. The C2 horizon can be stratified with layers of variable thickness ranging from fine sand to silt loam.

Foster sandy loam (0 to 2 percent slopes) (Fm).—This soil has the profile described as representative for the series. Drainage generally has been improved through lowering of the water table, though some areas near the foothills are somewhat poorly drained. Permeability is moderate to moderately rapid, and runoff is slow to very slow. Excess water does not pond on the surface for long but drains through the soil. The hazard of erosion is slight to negligible. The available water holding capacity is moderate.

This soil is mainly in the vicinity of Riverdale, Burrel, and Helm. A few small areas lie along small streams draining the foothills near Orange Cove and

Academy. Most of this soil has been smoothed or leveled, but some areas in the foothills and near Burrel are hummocky.

Also included with this soil in mapping was a minor area of similar soils that are mainly saline-alkali affected in the substratum. These included areas are near Burrel and Orange Cove They are indicated on the soil map by a saline or saline-alkali spot symbol, which is a small red cross for each 5 acres.

Alfalfa, cotton, corn, grain sorghum, and sugar beets are grown on this soil With well managed irrigation, fertilization, and pest and disease control, these field crops are well suited Irrigation is by furrows or border checks. The soil needs nitrogen and phosphorus for continued production After several years of cropping, cotton shows a response to potassium fertilizers. Irrigated pastures are also established on this soil with good results The small areas of this soil near the foothills are used for range in conjunction with larger areas of soils on terraces or uplands. Capability unit IIs-4 (17); range site not assigned; natural land type A1 1f; Storie index rating 86

Foster loam (0 to 2 percent slopes) (Fn).—This soil has a profile that is similar to Foster sandy loam, except for the loam texture of the surface layer. The underlying material, to a depth of about 30 inches, ranges from light loam to sandy loam. Below 30 inches, the material is commonly stratified with a coarser textured layer, particularly on the recent fan of the Kings River Areas of this soil that occupy the flood plains of small streams near the foothills are stratified with a somewhat finer textured material in many places. In these areas, the soil is strongly calcareous throughout and has a dark gray surface layer that overlies grayish brown to light-brown soil material. The available water holding capacity is low to medium

Many areas of this soil are located along minor streams near the foothills from Friant to Orange Cove. Other areas are near Burrel and Riverdale.

Included with this soil in mapping were some small areas of Chino and Grangeville soils. Also included were some areas of Foster loam underlain by an unrelated, hard layer at a moderate depth.

The use and management of this soil are similar to those of Foster sandy loam. Capability unit I-1 (17, 18); range site not assigned: natural land type A1-1f; Storie index rating 90.

Foster loam, saline-alkali (0 to 2 percent slopes) (Fo) —The surface layer of this soil is loam, but in small included areas it is fine sandy loam. The underlying material is loam to sandy loam to a depth of 30 inches, and below that depth it is stratified with coarser textured material. The underlying material is consistently saline-alkali affected. Areas of this soil that make up about half of the total acreage have up to one third of their surface layer similarly affected. In the remaining areas the surface layer is saline-alkali free. Where saline-alkali affected, the soil is strongly or very strongly alkaline and generally at least slightly saline from accumulations of neutral and basic salts. The condition originated in former times when the water table was closer to the surface and drainage was poorer.

This soil is presently moderately well drained to somewhat poorly drained. It is moderately permeable, and runoff is slow. The erosion hazard is slight. Reclaimed areas have medium to high available water capacity.

This soil is widely distributed in small areas. The largest of these are located east of Burrel and northwest of Riverdale. Smaller areas occupy parts of the minor flood plains of small streams near the foothills. These lie in Hill Valley, in the vicinity of Academy, and in the Dry Creek Reservoir area

Included with this soil in mapping were small areas of similar soils having a hummocky or channeled microrelief. These areas are in Clark Valley, Citrus Cove, and near Academy.

The use and management of this soil are similar to those of Foster sandy loam. After it is reclaimed, this soil is suited to such crops as alfalfa, cotton, corn, grain sorghum, and sugar beets. Reclamation of this soil is feasible. For a discussion of the methods of reclamation see the section "Saline and Saline-Alkali Soils." No attempt is made to reclaim the small areas of this soil near the foothills. They occur mainly near rangeland and are used only for grazing Capability unit IIs-6 (17); range site not assigned; natural land type A1-1f-2s; Storie index rating 43

Foster loam, moderately deep (0 to 2 percent slopes) (Fp) —This soil overlies an unrelated layer of compact, weakly cemented sandy material at a depth ranging from 24 to 40 inches. Except for this and a loam surface layer this soil has a profile similar to that of Foster sandy loam. The cemented material is brown to grayish-brown and ranges from 1 foot to several feet in thickness. It restricts root and water penetration. In places it is stratified with gray, compact, silty layers The surface layer is dark gray and in many places several inches thicker than the surface layer of the profile described as typical for the series. The material below the surface layer is commonly darker grayish brown. The soil is moderately well drained and strongly calcareous throughout. The available water capacity is moderate.

This soil is along many small creeks near the edge of the foothills from Citrus Cove to Academy. Many of these areas have been subject to seasonal flooding, which has resulted in an uneven, channeled microrelief. In places the channels are as deep as 4 feet. Few appear to be the result of recent flooding

This soil is used mainly for grazing, primarily because of its location. It lies mainly beyond the limit of developed, reliable sources of irrigation water and occurs in small areas that are near extensive rangeland Some areas that occur with larger areas of terraces or gently sloping uplands used for dryfarmed barley are also put to this use. Capability unit IIs-3 (17); range site not assigned: natural land type A9-1f; Storie index rating 47

Foster loam, moderately deep, saline-alkali (0 to 2 percent slopes) (Fr).—This soil overlies a layer of

unrelated, weakly cemented, sandy material at a depth ranging from 24 to 40 inches. The soil is saline-alkali affected. In places, the substratum of all areas of this soil is strongly alkaline and at least slightly saline. The surface layer of about half of the unit is not similarly affected.

Except for a single large area near Burrel, this soil is located in the same general area as Foster loam, moderately deep. The underlying material in the Burrel area is compacted, calcareous silt.

Included with this unit in mapping were small areas of fine sandy loam, of Chino soils, and of similar soils with fine-textured underlying material.

Except in an area near Burrel, no attempts have been made to reclaim this soil. There the soil is used for irrigated pasture. Along the edge of the foothills the soil is used for grazing because it lies beyond the limit of developed, reliable sources of water for irrigation and occurs with soils used for range. The forage consists of annual grasses, forbs, saltgrass, and some undesirable plants that are tolerant of saline-alkali conditions, such as spikeweed. Capability unit IIIs-6 (17); range site not assigned; natural land type A9-1f 2s; Storie index rating 88.

Fresno Series

The Fresno series consists of saline-alkali affected soils that lie in the basin rim zone, where they formed from granitic alluvium under somewhat poorly drained conditions. These soils have a moderately well developed subsoil resting on an indurated lime-silica cemented hardpan that is moderately deep or shallow. The soils are nearly level, but their natural surface has a rough, low, hummocky microrelief. Many of the hummocks have been formed by local heaping of material moved by wind. Most of them are partly eroded by wind or by local washing during the rainy season. Protective vegetation is varied and patchy because of strong saline-alkali conditions in the surface layer of these soils. The plant cover consists of annual grasses and forbs, as well as plants tolerant of saline-alkali conditions. Many small irregular depressions, which may be bare, are interspersed with low hummocks.

The Fresno soils occur in a wide, irregular belt that extends from about State Highway 180 west of Kerman, southeasterly to Caruthers, then in a discontinuous pattern to the northerly vicinity of Laton. The soils range in elevation from 175 to 250 feet. The average annual rainfall is about 8 inches; the average annual temperature is about 62° F., and the average growing season ranges by locality from 225 to 250 days.

Typically, Fresno soils have a surface layer of light-gray, moderately alkaline, calcareous fine sandy loam about 6 inches thick. This layer overlies a subsoil of grayish-brown light clay loam and light brownish-gray loam. The subsoil is strongly to very strongly alkaline and calcareous, and it is underlain by a light brownish-gray and light-gray indurated lime-silica hardpan about 7 inches thick. Below this is light-gray stratified sands and silts to a depth of 60 inches or more.

Reclaiming the Fresno soils is moderately difficult. After the soils are reclaimed, they are used for field crops and irrigated pasture. Unreclaimed areas are idle or are used for alkali pasture.

Representative profile in a natural range pasture supporting annual grasses and forbs mixed with salt- or alkali-tolerant plants at an elevation of 220 feet. Many small strongly saline-alkali affected areas are devoid of vegetation. (About 2¾ miles NW. of Raisin City in the NW¼SW¼NE¼ sec. 18, T. 15 S., R. 19 E.):

A1—0 to 6 inches, light-gray (2.5Y 7/2) fine sandy loam, grayish brown (2.5Y 5/2) when moist; weak, very fine, granular structure when moist, drying to massive with some cracking in a coarse prismatic pattern; hard when dry, friable when moist, very slightly plastic and nonsticky when wet; fine roots few in soil mass but numerous along the cracks and forming matlike root concentrations in places; many very fine interstitial pores, common microsize and very fine tubular pores; slightly calcareous; moderately alkaline (pH 8.1); abrupt, slightly wavy lower boundary.

B2t—6 to 12 inches, grayish-brown (2.5Y 5/2) light clay loam, dark grayish brown (2.5Y 4/2) when moist with darker (2.5Y 3/2 and 2/1) organic films on many ped faces; weak, coarse, prismatic structure, breaking to moderate, medium, angular blocky structure; very hard when dry, firm when moist, plastic and slightly sticky when wet; few fine roots in soil mass, roots more numerous and somewhat flattened along structural faces; common microsize and very fine tubular pores; slightly calcareous, with lime disseminated; common thin to moderately thick clay films on ped faces; strongly alkaline (pH 8.9); clear, slightly wavy lower boundary.

B3—12 to 21 inches, light brownish-gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) when moist; darker (2.5Y 4/2 and 3/2) organic films on some ped faces; weak, medium, subangular blocky structure; very hard when dry, firm to friable when moist, very slightly sticky and nonplastic when wet; few fine roots in soil mass; common microsize and very fine tubular pores; slightly calcareous, with lime disseminated; few thin clay films on ped faces; very strongly alkaline (pH 9.3); very abrupt, slightly wavy lower boundary.

C1rma—21 to 28 inches, variable light brownish-gray and light-gray (2.5Y 6/2 and 7/2), grayish brown (2.5Y 5/2) when moist; massive, indurated, lime-silica hardpan that has a very thin, very dense, dark grayish-brown (2.5Y 4/2) upper crust; thin indurated crusty material appears elsewhere in the hardpan but is thinner, more lenslike, and less continuous than on the upper surface of the hardpan; very thin, light-colored lime segregations and crusts also appear on the surface of the hardpan in some places and at various places within the horizon; the lower part of the horizon becomes more platy or fragmental; some fine roots that are flattened and matted in places follow cracks and joints in the hardpan; calcareous with little or no softening of the pan after treatment with dilute acid; very strongly alkaline (pH 9.1); abrupt, slightly wavy lower boundary.

C2ca—28 to 30 inches, light-gray (2.5Y 7/2) stratified fine sandy loam and loam and some thin lenses of silt, light brownish gray (2.5Y 6/2) when moist; few, faint, fine, yellowish-brown mottles; massive, hard when dry, friable when moist; no roots; common microsize and very fine interstitial pores, and few microsize and very fine tubular pores; moderately

calcareous, most of the lime being softly segregated in a reticulate pattern or in very thin, slightly hardened seams; very strongly alkaline (pH 9.3); clear, smooth lower boundary.

IIC3ca—39 to 68 inches, light-gray (2.5Y 7/1), stratified, thin to thick laminae of micaceous fine sand and silt, light brownish gray (2.5Y 6/2) when moist; variable patterns of few to many, fine, faint to distinct, yellowish-brown and strong-brown mottles; consistence is variable but mainly hard when dry, firm to very friable when moist; no roots; common microsize and few very fine interstitial pores, few microsize and very fine tubular pores; variably calcareous, lime both disseminated and segregated in very thin lenses or seams that are soft or somewhat hardened; strongly alkaline (pH 8.9); clear, smooth lower boundary.

IIC4—68 inches +, material similar to that of IIC3ca horizon but very slightly calcareous to noncalcareous in most of mass.

The color of the A horizon ranges from light brownish gray to grayish brown. It has a hue of 10YR or 2.5Y and typically a value-chroma combination of 7/2 or 6/2. When the A horizon is moist the hue and chroma do not change, but the value decreases, ranging from 6 to 4, and the soil material appears light brownish gray, grayish brown, or dark grayish brown. The A horizon is typically massive. In places it is broken by a coarse or very coarse, random pattern of thin vertical cracks. Also in places there are thin (approximately 1 inch thick) vesicular or platy crusts. Dry consistence ranges from hard to very hard. The A horizon is typically slightly to moderately calcareous, although in places it is noncalcareous at the very surface. Its reaction ranges from moderately to very strongly alkaline. The texture of the A horizon is generally sandy loam, fine sandy loam, or loam. In a few places the texture is clay loam.

The color of the B horizon generally ranges from light brownish gray to dark grayish brown, but in some places it ranges to light olive brown or olive brown. The hue is typically 10YR or 2.5Y, the value is 4 or 6, and the chroma is 2. In places the chroma is 4 and the hue 2.5Y. The darker stains of organic films on the ped faces are variable; they are absent in places. When moist, the colors do not change greatly, being most commonly dark grayish brown. In some places, however, they are grayish brown or olive brown. The texture of the Bt horizon ranges from heavy loam to clay loam or sandy clay loam. The structure is normally moderate to strong angular blocky, but in places it also shows a weak to moderate prismatic structure that breaks readily to angular blocky upon being disturbed. The reaction ranges from moderately to very strongly alkaline. The B horizon is slightly calcareous or calcareous, the lime either disseminated or both disseminated and segregated in irregular, soft blotches.

The depth to hardpan ranges from about 12 to 48 inches, but the average is about 36 inches. The thickness of the hardpan ranges from a few inches to about 18 inches. In some places in the C horizon, there is uncemented light-gray to pale-yellow fine sandy loam to loam between the B2t or B3 horizon and the hardpan horizon. In places several hardpan layers underlie the first hardpan layer and are separated by material similar to the C2ca or IIC3ca horizon.

Fresno fine sandy loam (0 to 2 percent slopes) (Fu).—This soil is variably saline-alkali affected. It has the profile described as typical for the series. The depth to hardpan ranges from 20 to 48 inches. Deep borings have shown that where a sequence of cemented layers occurs in depth, the sequence seldom extends below a depth of about 10 feet.

Except in a limited area of reclaimed soil, the subsoil of this soil is strongly to very strongly alkaline and at least slightly saline from the accumulation of salts. The surface layer is variably affected. From area to area, the affected part ranges from less than 5 percent of the surface area to more than 66 percent. Those areas in which the surface layer is saline-alkali free have a more uniform cover of annual grasses and forbs and fewer plants that are tolerant of salts and alkali. The proportion of bare spots or scald spots increases with the proportion of surface area affected.

The general lowering of the water table under the basin rim has altered the natural drainage, and this soil is now moderately well drained. Runoff is very slow, and it is locally ponded. Leveling and grading of the surface eliminate the local ponding. The permeability is very slow but can be improved by deep ripping of the hardpan. The hazard of erosion is slight or none. The hazard of erosion is related to the low hummocks on the natural surface. Available water holding capacity is low to moderate. However, there is only limited use of this water by plants unless the soil is reclaimed.

Many small playas, about 5 to 20 feet in diameter, were included with this soil in mapping. Also included were many small areas where the surface layer is loam; small areas of El Peco, Pond, and Traver soils; and narrow stringers of Hesperia and Cajon soils.

Natural areas of this soil are used for alkali pasture for beef cattle and dry dairy cattle. Much of this soil is being reclaimed for cropland. Reclamation requires considerable investment and care, but it is feasible. For a discussion of reclamation procedure see the section "Saline and Saline-Alkali Soils."

If this soil is reclaimed, it is well suited to alfalfa and irrigated barley. It is well suited to irrigated pasture even without complete reclamation. Fair crops of cotton, corn, grain sorghum, and sugar beets can be grown. Fertilization with nitrogen and phosphorus is required; potassium may be needed for cotton. When first used for crops, this soil is free of many soilborne pests and diseases that have long been established in better soils elsewhere. This desirable condition can be maintained if care is taken to see that soil from infected areas is not carried into areas of this soil. One of the most common sources of infection is farm machinery that has been used on infected soils. Capability unit IIIs-6 (17); range site not assigned; natural land type B13-2m; Storie index rating 16.

Fresno clay loam (0 to 2 percent slopes) (Fw).—The profile of this soil is similar to that of Fresno fine sandy loam, but it has a finer textured surface layer and a somewhat finer textured subsoil. In addition, the depth to hardpan is less; it ranges from 12 to 24 inches but is mainly about 18 inches.

This soil is several miles southwest of Kerman in the oilfield district. Areas of this soil occupy slightly depressional positions in relation to other soils of the Fresno series. Under natural conditions, the soil has a variable surface appearance. Light-gray, nearly barren, saline-alkali affected spots are partly separated by narrow, very low, interconnected hummocks of loam or fine sandy loam that support short annual grasses and alkali-tolerant plants. The coarser textured material in the hummocks does not change the general texture of the surface layer on mixing. The

surface appearance reflects the fact that nearly all of this soil is saline-alkali affected in both the surface layer and the subsoil.

This soil provides only poor alkali pasture and is difficult to reclaim. Because of the moderately fine texture, leaching is slow even though the soil is deeply ripped and mixed. The soil is well suited to irrigated pasture. Capability unit IIIs-6 (17); range site not assigned; natural land type B13-2a; Storie index rating 3.

Fresno fine sandy loam, shallow (0 to 2 percent slopes) (Fv).—The profile of this soil is similar to Fresno fine sandy loam, but is shallower to a hardpan. Depth to hardpan ranges from 12 to 24 inches but is commonly less than 20 inches. The soil is more extensively affected with salts and alkali in its surface layer than is Fresno fine sandy loam. The available water holding capacity is low to very low. However, not all of this is usable unless the soil is reclaimed. Annual grasses that grow on natural areas of this soil are very short. They dry up and mature seed early in spring.

Included with this soil in mapping were small areas in which the depth to hardpan is as much as 30 inches. A moderately extensive area of a similar soil having a loam surface layer was also included. This included area is mainly in the vicinity of the Noble Ranch feedlot north of Helm. Another small area is northeast of Whites Bridge.

This soil provides only fair alkali pasture. Reclamation of the soil is feasible, but ripping brings many fragments of hardpan to the surface that need to be cleared to facilitate subsequent cultivation. Under good management, reclaimed areas of this soil produce fair growth of irrigated barley, cotton, and grain sorghum. The soil is well suited to irrigated pasture. Capability unit IIIs-6 (17); range site not assigned; natural land type B13-2a; Storie index rating 4.

Fresno sandy loam (0 to 2 percent slopes) (Fs).—The profile of this soil is similar to that of Fresno fine sandy loam, but it has a sandy loam surface layer and a sandy clay loam subsoil. The distribution of saline-alkali affected areas in the surface layer and subsoil is very similar to that of Fresno fine sandy loam. The available water holding capacity is low. The soil must be reclaimed before all of this water is used by normal plant growth.

Fresno sandy loam is in many areas of varying size from the vicinity of Caruthers and Raisin City northwestward to the vicinity of Tranquillity. Included with this unit in mapping were minor areas of completely reclaimed soils that are near Kerman and east of Tranquillity.

Natural areas of this soil provide fair to good alkali pasture. With reclamation, use and management of this soil are similar to those of Fresno fine sandy loam. Capability unit IIIs-6 (17); range site not assigned; natural land type B13-2m; Storie index rating 15.

Fresno sandy loam, shallow (0 to 2 percent slopes) (Fl).—The profile of this soil is similar to that of Fresno fine sandy loam, but is shallower to a hardpan. It has a sandy loam surface layer and a sandy clay loam subsoil. Most of the soil is saline-alkali affected in both the surface layer and subsoil. The available water holding capacity is very low. The soil is in areas of varying size along the basin rim.

Alkali pasture grasses have a very short season of growth and produce little forage. The soil is reclaimable but perhaps is best suited to irrigated pasture. Capability unit IIIs-6 (17); range site not assigned; natural land type B13-2a; Storie index rating 4.

Fresno-Traver complex (0 to 2 percent slopes) (Fx).—This complex consists of saline-alkali affected Fresno and Traver fine sandy loams in such an intricate pattern that it is impractical to separate them at the scale used in mapping. The surface is nearly level to slightly hummocky. Each of the soils named occupies at least 20 percent of any given area mapped as the complex. The profiles are similar to those described as typical for the respective series.

This complex is north of Helm. The Traver soils developed in alluvium along graded, complexly braided streamways that cut into an area of older, stratified material in which the Fresno soils developed. Included with the Traver soils are stringlike areas of saline-alkali affected Hesperia sandy loam and fine sandy loam that have been slightly modified by wind in places. Small areas of El Peco and Pond soils have been included with the Fresno soils.

In its natural state, more than two-thirds of the surface layer of the soils in this complex is saline-alkali affected. Parts of the complex have been leveled and are now reclaimed or partly reclaimed. In their natural state, the soils are used for alkali pasture or are idle. Reclaimed areas are used for irrigated pasture, cotton, alfalfa, and grain sorghum, and when fully reclaimed, the soils are suited to these crops. Capability unit IIIs-6 (17); range site not assigned; natural land types B13-2a and B1-2m; Storie index rating 10.

Friant Series

The Friant series consists of shallow, well-drained and somewhat excessively drained soils of the uplands that formed from the weathering of quartz mica-schist having nearly vertical planes of cleavage. The soils lack a subsoil. They are rolling to steep and occupy hilly terrain having a low hummocky microrelief in places. This is similar to the hogwallow, or mimamound, microrelief typical of shallow soils on terraces.

The Friant soils are in the northern part of the lower foothills at elevations of 500 to 2,000 feet. Most of the acreage, however, lies below 1,200 feet. According to elevation, average annual rainfall ranges from 15 to 20 inches; average annual temperature from 62° to 60° F.; and average frost-free season from 200 to 250 days. The natural vegetation consists of annual grasses and forbs.

Typically the soils are brown, slightly acid to neutral fine sandy loam that has a moderate content of organic matter. Slightly weathered parent rock is at a depth of about 14 inches.

These soils are used principally for grazing. The natural growing season for the cover of annual grasses and forbs ranges from about 90 to 180 days, depending upon the amounts and distribution of rainfall. Small, short-lived, intermittent streams provide the only local sources of water available in areas of these soils.

Representative profile in an area of annual-grass range on a southeast-facing slope, at an elevation of about 525 feet (3/4 mile, airline, NE. of the town of Friant in the SW1/4NE1/4NW1/4 sec. 8, T. 11 S., R. 21 E.)

A11—0 to 3 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) when moist, weak, fine to medium, granular structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; abundant fine and very fine roots, common fine tubular pores, many very fine interstitial pores, some angular pebbles of aplite, vein quartz and parent rock, slightly acid (pH 6.4), abrupt wavy lower boundary.

A12—3 to 14 inches, brown fine sandy loam (10YR 5/3), dark brown (10YR 3/3) when moist, massive, slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; plentiful fine roots, many fine and very fine tubular and irregular pores, occasional angular pebbles of aplite, vein quartz and parent rock, neutral (pH 6.6), abrupt, irregular lower boundary.

R—14 inches +, gray to yellowish brown, slightly weathered quartz mica schist with very steeply dipping planes of schistocity, thin reddish brown clay films coat some of the minor joint or fracture surfaces within the upper 6 inches; a few roots penetrate along these fractures; occasional quartz or aplite veins cut through the parent rock.

The texture of the A horizon is sandy loam or fine sandy loam. Depth ranges from 6 to 20 inches. Rock outcrops are uncommon. In places there are small gravelly or cobbly areas where angular fragments of quartz or aplite have accumulated from the weathering out of swarms of vein rock in the parent rock.

The color of the soil is typically brown. The color of the A11 horizon is generally the same as that of the A12 horizon, but it is somewhat darker in places. The hue is commonly 10YR but ranges to 7.5YR. The value is 5 or 4, and the chroma, 3. In places the chroma is 4 if the hue is 7.5YR. When moist, the soil is dark brown. The areas having a hue of 10YR have a value and chroma of 3. Those areas having a hue of 7.5YR have a value of 3 and a chroma ranging from 2 to 4. The brighter chroma occurs in the subsurface layer.

The A11 horizon generally has a weak granular structure but is massive in places where trampled by grazing animals. The A12 horizon is typically massive. The A11 and A12 horizons are consistently slightly hard when dry and friable to very friable when moist. Both horizons range from slightly acid to neutral.

Friant fine sandy loam, 30 to 45 percent slopes (FyE).—The profile of this soil is very similar to that described as representative for the series. This soil is somewhat excessively drained. The soil is moderately permeable, the steeply inclined planes of cleavage and schistocity in the parent rock permit some infiltration and storage of water percolating through the soil. Runoff is generally rapid. Unless the soil is protected by a good cover of grass, the hazard of erosion is high. The available water holding capacity is very low, but some additional moisture is available to roots that penetrate into the slightly weathered rock along cleavage planes.

Most of this steep soil is located on the hills east of the town of Friant. Some areas are also on the watershed of Fancher Creek and on slopes of Deer Creek Canyon north of Pine Flat Reservoir.

Included with this soil in mapping were small areas of a similar soil having much steeper slopes. Also included were areas having some outcropping of parent rock. These included areas are on the watersheds of Fancher Creek and Deer Creek.

This soil is used mainly for livestock grazing late in winter and in spring. It produces good forage, but unless rainfall is well distributed late into spring, the soil and forage dry up early in the green-feed season. The larger areas of this soil near Friant are easily accessible, and fertilizer can be spread on the slopes. Nitrogen improves grass growth, and sulfur stimulates the clovers. However, because of the very low available water holding capacity, response to fertilization is dependent largely on rainfall distribution, which is not predictable from season to season.

Along the edge of Millerton Lake the soil is used for recreational purposes. The steep slopes do not form good beaches. Wave action cuts shallow step terraces as the lake level fluctuates and leaves little sand. In gently sloping included areas, use of the waterfront quickly muddies the onshore waters. Better beaches are more easily developed on adjacent shoreline soils from granitic rock. Picnic areas have been successfully developed where water is available and trees can be established for shade. Capability unit VIIe-4 (18); range site 7; natural land type E13, Storie index rating 12.

Friant fine sandy loam, 9 to 30 percent slopes (FyD).—This soil is well drained. Runoff is medium to rapid, and the hazard of erosion is generally moderate. The soil is rolling to hilly and is shallow. It occurs mainly in the vicinity of Friant, near Owens Mountain, and on a part of the upper drainage of Fancher Creek.

Included with the soil in mapping were small areas of a similar soil as much as 30 inches deep; an isolated knob west of Owens Mountain having slopes of less than 9 percent, and an area near Pine Flat Reservoir having many low irregular outcrops of parent rock.

This soil is used only for grazing. The management is similar to that of Friant fine sandy loam, 30 to 45 percent slopes. In most places fertilizer is more easily applied to the surface of this soil. Response to fertilizer, however, is dependent upon the amount and seasonal distribution of rainfall. If irrigation water were available, this soil would be well suited to pasture irrigated by sprinklers. Capability unit VIe-41 (18); range site 7; natural land type E5; Storie index rating 24.

Grangeville Series

The Grangeville series consists of moderately coarse textured soils that formed in recent granitic alluvium where drainage was somewhat poor. The soils have

moderately rapid permeability and lack a subsoil. In recent years, flood-control and storage dams, as well as a general lowering of the water table by widespread pumping, have improved the drainage of these soils in most places.

These soils are nearly level; they occupy secondary flood plains along the main rivers and some smaller streams and parts of the recent fans of the rivers. The natural surface is commonly smooth, but in places it is laced by former, shallow flood channels that wander out from the active streamways. Most of these channels are overgrown with vegetation. The natural plant cover consists of annual grass and forbs, some saline-alkali-tolerant plants in places, and scattered valley oak. Adjacent to the rivers, the vegetation was more dense and includes shrubs, vines, and willows.

These soils are mainly on the Kings River bottom lands near Sanger and the recent fan of the same river in the vicinity of Laton and Riverdale. Some areas are on the recent flood plains of the San Joaquin River and smaller streams draining the foothills. The soils are at elevations of 160 to 500 feet. Average annual rainfall ranges from 8 to 12 inches. However, because of their low-lying position the soils do not drain rapidly from flooding or seepage and have acquired characteristics that reflect a more humid climate. The average annual temperature is 62° F.; the average growing season is 225 days.

The surface layer is typically grayish-brown, neutral fine sandy loam that is about 8 inches thick and contains a moderate accumulation of organic matter. The surface layer overlies thick layers of pale brown neutral and moderately alkaline fine sandy loam that is weakly mottled in many places and typically calcareous below a depth of about 20 inches.

Under irrigation, these soils are suited to vineyards, alfalfa, cotton, truck crops, and some orchard crops. Some less well drained, unimproved areas are used for pasture or browseland. Others are used for irrigated pasture. Mixtures seeded for pasture should consist mainly of grasses and contain few or no legumes. These soils, like most soils of basins or alkaline flood plains, contain more soluble molybdenum salts than better drained, less alkaline soils. Molybdenum is taken up more by legumes than by grasses, and sufficient amounts can be accumulated to cause molybdenum toxicity in cattle feeding on the plants. Water for irrigation is obtained from shallow to moderately deep wells.

Representative profile in a walnut orchard in a very gently undulating area, at an elevation of about 330 feet. (About 4 miles, airline, SE. of the town of Sanger in the Kings River bottom lands; 200 feet SW. of the N. quarter-corner of sec. 6, T. 15 S., R. 23 E.):

Ap—0 to 8 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine to medium, granular structure with a weak tillage pan developed in the lower part of the horizon; soft when dry (slightly hard in the tillage pan), very friable when moist; nonsticky and nonplastic when wet; plentiful fine and very fine roots (few in the tillage pan); many very fine interstitial pores; micaceous, neutral (pH 6.6); gradual, wavy lower boundary.

C1—8 to 34 inches, pale-brown (10YR 6/3) fine sandy loam, dark brown (10YR 4/3) when moist; few, fine to medium, faint mottles of yellowish brown; massive, soft when dry, very friable when moist; nonsticky and nonplastic when wet; few coarse roots, many microsize interstitial pores, micaceous occasional filaments of lime in the lower part of the horizon, neutral (pH 7.0); gradual, wavy lower boundary.

C2—34 to 60 inches, pale-brown (10YR 6/3) fine sandy loam, dark yellowish brown (10YR 4/4) when moist; few, fine to medium, faint yellowish mottles, and few, fine to medium, prominent reddish mottles; massive; soft when dry, very friable when moist; nonsticky and nonplastic when wet; few coarse roots, many microsize interstitial pores; micaceous; variably calcareous with both disseminated and segregated lime, the latter in the form of fine, soft filaments; moderately alkaline (pH 8.2), grades into variably stratified, similar alluvium many feet thick.

The color of the A horizon is brown, grayish brown, or dark grayish brown, but it is typically grayish brown. The hue is generally 10YR, but in places it is 2.5Y, and the value-chroma combinations are 4/2, 5/2, and 5/3. The moist color is typically very dark grayish brown. The hue remains the same, but the value is only 3 and the chroma is 2. Texture of the A horizon ranges from sandy loam or fine sandy loam to loam. The structure of the A horizon is weak to strong, fine to medium granular or weak, fine to medium subangular blocky. In places, the A horizon is massive or cloddy. Dry consistence ranges from slightly hard to soft; moist consistence is friable to very friable; wet consistence is nonsticky to slightly sticky and nonplastic to slightly plastic. The A horizon normally ranges from slightly acid to mildly alkaline and is generally noncalcareous. Where saline-alkali affected, the A horizon is strongly alkaline in places and effervesces readily with dilute acid.

The C horizons are similar in texture to the A horizon; there is little or no contrasting stratification of alluvial materials. Color is commonly pale brown or brown and is grayish brown or dark grayish brown in places. The hue is 10YR, the value is 5 or 6, or in places 4. The chroma is commonly 3, but in places it is 2. The moist color is commonly dark brown or dark yellowish brown, but in some places it is dark grayish brown or very dark grayish brown. The hue remains the same, the chroma remains the same in many places, but it brightens to 4 or darkens to 2 in some places; the value decreases to 3 or 4. Mottling is variable but is commonly faint and yellowish or grayish. In some places it is prominent and reddish. Structure is lacking in the C horizon, and the consistence is similar to that for the A horizon. Reaction normally ranges from neutral to moderately alkaline but is strongly alkaline in areas of the soil that are saline-alkali affected. Lime is typically present, occurring at a depth ranging from 15 to 40 inches within short distances. It is in disseminated form and as thin filaments or small soft masses.

These soils are normally very deep. Some areas, however, overlie unrelated layers of gravel, sand, or weakly cemented sandy material at a depth of 2 to 5 feet.

Grangeville fine sandy loam (0 to 2 percent slopes) (Gf).—This soil has the profile described as typical for the series. Runoff is slow because this soil is nearly level. The available water holding capacity is high. Permeability is moderately rapid. The effective root zone is at least 60 inches deep. The hazard of erosion is slight to none.

This soil is mainly on the Kings River flood plain in the river bottoms near Sanger. It is also on the flood plains of the San Joaquin River and other entrenched, lesser streams draining the lower foothills and valleys.

Included with this soil in mapping were small areas

having a loam surface layer; these are mainly along the lower flood plain of the San Joaquin River northeast of Whites Bridge. Also included were randomly scattered areas of similar soils that are noncalcareous to a depth of more than 60 inches. In addition, there are small inclusions of similar soils having slopes of more than 2 percent or that are channeled and rough surfaced from flooding.

This soil is well suited to alfalfa, irrigated barley, corn, cotton, grain sorghum, sugar beets, a variety of truck crops, and table or raisin grapes. Some peaches, plums, and walnuts are grown with fair success. This soil is not used for citrus crops, because of a frost hazard related to the low-lying position in areas that can become cold pockets during winter. Good irrigated pastures have been developed on this soil.

The soil is easily tilled and readily worked into a good seedbed. Because of a high available water holding capacity, optimum moisture content can be maintained with a fairly wide spacing of irrigation periods. Fertilization with nitrogen and phosphorus is seasonally needed to maintain good growth of field crops. In places, cotton responds to potassium. The tree and vine crops are generally fertilized with nitrogen. Weed control is a continuing and difficult problem in many areas. Capability unit I-1 (17, 18); range site not assigned; natural land type A1-1f; Storie index rating 90.

Grangeville fine sandy loam, saline-alkali (0 to 2 percent slopes) (Gd).—The profile of this soil is similar to Grangeville fine sandy loam, but is generally saline-alkali affected in the underlying material. About one-third of the areas of this soil shows no surface effects of salts and alkali, but about one-fifth of the acreage shows definite surface effects in the form of bare spots and areas of depressed growth on one-third to more than two-thirds of the surface. The rest of the acreage shows similar surface effects on less than one-third of the surface area. The patterns of affected surface areas are very complex and variable. Where the surface soil does not exhibit bare spots of depressed growth, it is essentially saline-alkali free.

This soil is in many areas along the bottom lands of the San Joaquin River and Kings River; along small creeks, near Academy, Clovis, and Round Mountain; and on the recent fan of the Kings River near Laton, Riverdale, and Burrel.

Included with this soil in mapping were minor areas of similar soils having a loam surface layer or channeled rough microrelief.

Undeveloped areas of this soil are used for grazing. With incomplete reclamation, fair to good irrigated pasture can be established. With sufficient care and investment, complete reclamation of the normal rooting depth for most crops, except tree crops, is feasible. Methods used in reclamation are discussed in the section "Saline and Saline-Alkali Soils." After reclamation, use and management are similar to those for field crops on Grangeville fine sandy loam. Capability unit IIs-6 (17); range site not assigned; natural land type A1-1f-2s; Storie index rating 72.

Grangeville fine sandy loam, water table (0 to 2 percent slopes) (Gh).—The profile of this soil is similar to Grangeville fine sandy loam, but it is somewhat poorly drained. Locally the water table stands within 2 to 4 feet of the surface. As a consequence, in many places the lower part of the underlying material is mottled with bluish streaks and spots. The presence or absence of lime in the underlying material is variable from place to place. The surface layer is somewhat darker than the typical one, and the soil has a somewhat higher content of organic matter.

This soil is mainly in less well drained parts of the river bottoms near Sanger and Centerville. In these areas, natural seepage from streamflow and drainage from the irrigation of nearby higher areas tend to accumulate and maintain the local shallow water table. Natural drainage downstream from these areas is slow.

The soil is used only for grazing if undeveloped, or for irrigated pasture. A system of tiles and drainage ditches leading back into some of the distributary channels of the river can improve the soil by lowering the water table and increasing the use potential. Such improvement would permit field and truck crops to be grown. Capability unit IIw-2 (17); range site not assigned; natural land type A1-1p; Storie index rating 60.

Grangeville fine sandy loam, water table, saline-alkali (0 to 2 percent slopes) (Gk).—The profile of this soil is similar to that of Grangeville fine sandy loam except that it is somewhat poorly drained and is saline-alkali affected. The soil is fairly consistently affected within the underlying material above the water table. The surface layer is variably affected. Some areas are saline-alkali free.

The soil is only on the river bottoms east of Sanger and Centerville. The various areas of this unit lie close to areas of Grangeville fine sandy loam, water table. The level of the water table of this soil is slightly higher than that of Grangeville fine sandy loam, water table. Without improving the internal drainage by lowering the water table, this soil cannot be effectively reclaimed.

The soil is used for grazing or for irrigated pasture. Capability unit IIw-2 (17); range site not assigned; natural land type A1-1p-2s; Storie index rating 48.

Grangeville fine sandy loam, gravelly substratum (0 to 2 percent slopes) (Gl).—The profile of this soil is similar to Grangeville fine sandy loam, but it overlies a very thick layer of unrelated gravelly and cobbly material at a depth that ranges from 24 to 48 inches but commonly is 30 inches or more. Commonly the soil is light fine sandy loam throughout.

The permeability of this soil is reduced somewhat by the underlying material. The interface between the soil and gravel acts like a thin, less permeable layer within the soil. Additional force is needed to make draining water move from the soil into the gravel. This results in the building up of a saturated zone above the interface to a depth that provides the required hydrostatic pressure for the water to move into the gravel. The available water holding capacity is low because of shallowness.

This nearly level soil is mainly on the flood plains of the Kings River in the river bottoms east of Sanger. A few small areas are located on the flood plains of the San Joaquin River and Little Dry Creek, northeast of Pinedale.

Included with this soil in mapping were two small areas of similar soils that are slightly affected by saline-alkali conditions. One area is located along Little Dry Creek south of Friant, and the other is in the bottom lands east of Sanger. The latter included area is also affected by seepage water from the higher lying irrigated soils around Sanger. This water produces a local fluctuating water table that often rises to within 2 feet of the surface. A few thin streaks of gravel or cobblestones, essentially Riverwash, have also been included.

This soil is used largely for irrigated pasture. Some areas are used for corn, truck crops, and table and wine grapes, to which they are well suited. For other than irrigated pasture, care should be given to amounts of water applied per irrigation so as not to form and maintain a saturated zone above the gravelly interface. This would further limit the root zone. Frequent irrigation with a sufficient amount of water to moisten the soil to the depth of gravel is preferrable. Fertilization with nitrogen and phosphorus is needed. Capability unit IIs-0 (17); range site not assigned; natural land type A1-1f; Storie index rating 77.

Grangeville fine sandy loam, hard substratum (0 to 2 percent slopes) (Gn).—The profile of this soil is underlain by a compact, generally weakly cemented layer of unrelated material. This distinguishes it from the more freely drained profile of Grangeville fine sandy loam. The cemented layer is generally several feet thick and is at a depth that ranges from 2 to 5 feet but commonly is about 3 feet. The substratum is slowly permeable and is fractured in places. Where it is sandy material, it is generally weakly cemented. Where it is silty material, it is compact and seldom cemented, except for lime crusts or seams in places. The weakly cemented, sandy material is more frequently associated with areas of the soil along small streams near the foothills. Areas underlain by silty material are commonly on the recent fan of the Kings River near Riverdale. Both kinds of material effectively restrict internal drainage.

Periodic perching of excess water draining into the soil from prolonged rainstorms, or from overirrigation, creates a saturated zone within the soil above the compact layer. The excess water drains away slowly, but if it is permitted to persist, particularly from continued overirrigation, the effective rooting zone is further limited in depth. The available water holding capacity is moderate.

The soil is mainly near Academy, Dry Creek Reservoir, Laton, Riverdale, and Burrel. Included with this soil are small areas of similar soils near Riverdale having a surface layer of loamy sand or sandy loam.

This soil is used for pasture or, near the foothills, for range where it is near other much more extensive soils used for range. Elsewhere the soil is used mainly for cotton, grain sorghum, some field corn, alfalfa, and for irrigated pasture. Management is similar to that of Grangeville fine sandy loam, gravelly substratum. Deep ripping can break up some of the substratum and improve the effective soil depth. Capability unit IIs-3 (17); range site not assigned; natural land type A9-1f; Storie index rating 63.

Grangeville fine sandy loam, hard substratum, saline-alkali (0 to 2 percent slopes) (Go).—This soil is similar to Grangeville fine sandy loam, but at a depth of 2 to 5 feet this soil is underlain by a compact, generally weakly cemented, unrelated layer commonly several feet thick. This soil is generally saline-alkali affected in the underlying material and variably affected in the surface layer. A small proportion of the acreage shows effects in the surface layer, and an equally small proportion has more than a third of the surface layer affected. In most areas less than one-third of the surface layer is strongly alkaline and contains at least a slight accumulation of salts.

Areas of this soil are near Friant, Academy, Round Mountain, Laton, Riverdale, and Burrel. Small areas have been included in the unit which have channeled, uneven surface microrelief.

Without reclamation, this soil is used only for grazing or for fair irrigated pasture. With reclamation, the soil can be used for such crops as cotton, grain sorghum, corn, and alfalfa. Management is similar to that of Grangeville fine sandy loam, hard substratum. Methods of reclamation are discussed in the section "Saline and Saline-Alkali Soils." Capability unit IIIs-6 (17); range site not assigned; natural land type A9-1f-2s; Storie index rating 38.

Grangeville fine sandy loam, sandy substratum (0 to 2 percent slopes) (Gm).—The profile of this soil is similar to that of Grangeville fine sandy loam, except that it overlies thick layers of loose, stratified coarse and medium sands at a depth ranging from 30 to 48 inches. The sand layers are generally mottled with yellowish brown stains and are noncalcareous.

The available water holding capacity is moderate. The sandy underlying material tends to restrict drainage unless the soil above the sand interface is saturated. Roots do not readily penetrate or grow in sandy material.

Areas of this soil are on the recent fans of the San Joaquin River north and northeast of Whites Bridge, of the Kings River near Laton and Riverdale, and of Dry Creek near Clovis. In places, small areas of Dello soils have been included.

This soil is suited to such crops as irrigated pasture, corn, truck crops, and table and wine grapes. Leveling of the soil may expose the sand in places and this causes an uneven pattern in irrigation requirements in the fields prepared for cropping. Capability unit IIs-0(17); range site not assigned; natural land type A1-1f; Storie index rating 77.

Grangeville sandy loam (0 to 2 percent slopes) (Ga).—The profile of this soil is sandy loam in the surface layer and underlying material. In places the underlying material is stratified with fine sandy loam

The available water holding capacity is low, which requires somewhat more frequent irrigation to keep the moisture at an optimum level for crops.

The use and management of this soil are about the same as those for Grangeville fine sandy loam. Capability unit IIs-4 (17); range site not assigned; natural land type A1-1f; Storie index rating 86.

Grangeville sandy loam, saline-alkali (0 to 2 percent slopes) (Gd).—This soil is similar to Grangeville fine sandy loam but has sandy textures throughout its profile and is saline-alkali affected. The soil is generally affected below plow depth. More than one-fourth of the acreage shows no similar effects in the surface layer. In the rest of the acreage, 5 to 33 percent of the surface layer is affected. Available water capacity is moderate if the soil is reclaimed.

Several areas of this soil are near Pinedale, Selma, Kingsburg, and Riverdale. Some included areas near Pinedale have a light sandy loam or loamy sand surface layer.

Unless the soil is reclaimed, only poor growth is obtained for the field crops generally grown. Reclamation is feasible and once accomplished, the use and management of this soil are similar to those for Grangeville fine sandy loam, except that periods between irrigations are somewhat shorter. Deep rooted crops, particularly tree crops, are poorly suited to the reclaimed soils. Capability unit IIs-6 (17); range site not assigned; natural land type A1-1f-2s; Storie index rating 61.

Grangeville sandy loam, sandy substratum (0 to 2 percent slopes) (Ge).—The profile of this soil is similar to Grangeville fine sandy loam, except that it is sandy loam in the surface layer and the material just below it. This material overlies a thick, loose, sandy layer. Depth to the sandy layer ranges from 30 to 48 inches. Available water capacity is low.

This soil is mainly east of Riverdale, and north to northeast of Whites Bridge. Small areas of the somewhat more droughty Delhi sandy loam were included in mapping.

Natural areas of this soil are used for grazing. Where developed and irrigated, the soil is used mainly for pasture and for cotton. The management of the soil for pasture and cotton is similar to that for Grangeville fine sandy loam, gravelly substratum. The frequency of irrigation is somewhat greater, and cotton growth can be improved by potassium fertilizers. Capability unit IIIs-4 (17); range site not assigned; natural land type A1-1f; Storie index rating 68.

Grangeville soils, channeled (0 to 9 percent slopes) (Gp).—This mapping unit is an undifferentiated group of Grangeville sandy loams and fine sandy loams that occupy riparian areas along parts of the San Joaquin and Kings Rivers, their distributaries, and some of the larger creeks. It lies slightly higher than Riverwash and supports a dense natural cover of trees, vines, shrubs, grass, and weeds. The soils are often subject to minor overflow from the adjacent streams, and they have an unevenly channeled surface where the depth of channels ranges from 1 to 5 feet within horizontal distances of 17 to 50 feet. Many small areas of Riverwash and Tujunga soils are included.

These soils are used mainly as browseland for livestock. Some areas have been developed for streamside recreation. Others along the rivers have been cleared, leveled, and converted to irrigated pastures. This latter use has only become feasible since flood control has been achieved through the building of Friant and Pine Flat Dams on the rivers. Much of this unit provides an ideal riparian habitat for many forms of wildlife. Capability unit IIw-2 (17); range site 11; natural land type A1-1p-5cb; Storie index rating 36.

Granitic rock land (GrF) is made up of areas in which 50 to 90 percent of the surface is occupied by outcrops of very slightly weathered granitic rock, mainly quartz diorite. The outcrops are light colored except for patches of gray or dark gray lichen growths. They vary greatly in size and shape, ranging from low-lying, broad, rounded forms to large angular rock masses standing 15 to 20 feet high. Most outcrops are irregularly shaped, subangular masses that are 3 to 10 feet in diameter and protrude 3 to 7 feet.

The soils between the outcrops are generally similar to adjoining soils that were derived from the same kind of rock. In many places, however, they consist of colluvial accumulations of coarse sandy loams.

This land is widely distributed throughout the foothills. It is commonly steep or extremely steep. Some areas, however, occupy ridges or hilltops and are gently sloping. The vegetation is supported by the existing soils or accumulations of soil material, and it ranges from annual grasses and forbs to a trees and shrubs cover.

Runoff is variable. It is very rapid in one place and slow in another, depending on the extent and shape of rocky surface, and on the size, depth, and orientation of rock cracks or soil-filled breaks between outcrops. In many places seasonal springs or seeps are located on the lower parts of some of the areas of this unit.

Included in this unit is a limited area of fairly large tracts consisting entirely of exposed granitic domes. These are smooth, single outcrops in which there are few or no crevices where soil material can accumulate. Also included is a minor area of rock land composed of quartz mica-schist having very steeply dipping planes of cleavage. Much of the rock is also well jointed and this gives its surface a very rough, angular appearance. Parts of this inclusion consist of exceedingly stony colluvium from the same type of rock. The associated soil is similar to Coarsegold fine sandy loam. Bodies of this inclusion are on parts of the watershed of White Deer and Lefever Creeks.

Granitic rock land is a poor range site, but it does provide some forage and browse for livestock. Many parts of it are excellent refuge areas for wildlife. In many places the land type is an important segment of small watersheds. Road construction through areas of this land is normally expensive, but once constructed the roadbeds are generally very stable. Capability unit VIIIs-8 (18); range site not assigned; natural land type E17; Storie index rating 5.

Greenfield Series

The soils of the Greenfield series are deep, well drained, and moderately coarse textured and they have a moderately permeable subsoil. These soils formed in young granitic alluvium that is poorly sorted and contains many coarse particles. The nearly level to moderately sloping soils are on smooth fans of many streams draining into the San Joaquin Valley from the foothills.

The Greenfield soils are mainly in the Fresno-Clovis district and in the Reedley-Navelencia district. They are also in some foothill valleys. They are at elevations of 250 to 500 feet in the San Joaquin Valley and as much as about 2,000 feet in some of the foothill valleys. Average annual precipitation ranges from 9 to 17 inches. The average annual temperature is about 62° F. in the Valley and is about 60° F. at higher elevations in the foothill valleys. The frost free season ranges from 200 to 275 days. The natural vegetation consists of annual grasses and forbs. Some valley oak grows in the foothills.

In a typical profile, the surface layer is pale-brown and brown sandy loam that is low in organic matter content and is about 16 inches thick. The subsoil is brown sandy loam that contains slightly more clay than the surface layer and extends to a depth of about 50 inches. Below this depth is brown coarse sandy loam with less clay. The profile is neutral to slightly acid.

Where irrigated, these soils are suited to most climatically adapted crops. Greenfield soils that are only moderately deep to cemented material are not well suited to deep-rooted tree fruit and nut crops. In the foothill area the soils are used for range or for improved pasture.

Representative profile in a peach orchard on a nearly level former flood plain of a small stream, at an elevation of about 385 feet. (About 2½ miles SE. of Wahtoke on the S. side of Jefferson Avenue, 95 feet W., 85 feet S. of the center of sec. 1, T. 15 S., R 23 E.):

Ap—0 to 8 inches, pale-brown (10YR 6/3) when rubbed, light grayish-brown (10YR 6/2, 5/2) when broken, sandy loam, dark (10YR 3/3) when moist, cloddy, hard when dry, friable when moist; no roots, many very fine interstitial pores; some fine gravel fragments of quartz and feldspar; neutral (pH 7.3); clear, smooth lower boundary.

A1—8 to 16 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) when moist; massive, hard when dry, friable when moist, nonsticky and nonplastic when wet; very few medium roots; very few medium and common very fine tubular pores, many very fine interstitial pores; some fine gravel fragments of quartz and feldspar; slightly acid (pH 6.5); clear, wavy lower boundary.

B21t—16 to 38 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) when moist, weak medium subangular blocky structure; hard to very hard when dry, friable when moist, slightly sticky and slightly plastic when wet, very few medium roots, very few medium and few very fine tubular pores, many microsize interstitial pores; few thin clay films on ped faces and in tubular pores; some fine gravel fragments of quartz and feldspar; slightly acid (pH 6.4); clear, wavy lower boundary.

B22t—38 to 50 inches, brown (10YR 5/3) coarse sandy loam, dark brown (10YR 4/3) when moist; weak coarse subangular blocky structure; hard to very hard when dry, friable when moist, slightly sticky and nonplastic when wet; very few medium roots; few very fine tubular pores; many microsize irregular pores; few thin clay films on ped faces; clay bridging between sand grains, and some interstitial pores filled with clay; slightly acid (pH 6.8); abrupt, wavy lower boundary.

C—50 to 60 inches +, brown (10YR 5/3) coarse sandy loam, dark brown (10YR 4/3) when moist; massive; hard when dry, friable when moist, nonsticky and nonplastic when wet; many fine, very fine, and microsize interstitial pores; slightly acid (pH 6.5).

The color of the A horizon generally ranges from brown to pale brown, but it is grayish brown in places. The hue is 10YR, the value is 5 or 6, and the chroma is mainly 3 but in some places is 2. Moist colors are commonly dark brown but range to very dark grayish brown. The hue and chroma are similar, but the value is only 3 or 4. Texture of the A horizon is sandy loam or coarse sandy loam. The A horizon is typically massive and hard when dry but may appear weakly granular when moist. The reaction ranges from slightly acid to neutral.

The B horizon is typically brown. The hue is 10YR or 7.5YR, the value is 4 or 5, and the chroma is 3 or 4. When moist, the B horizon is dark brown, and the hue is similar. Value-chroma combinations of 3/3 and 4/3 are associated with a hue of 10YR, and combinations of 3/2 and 4/2, with a hue of 7.5YR. The texture is generally similar to that of the A horizon but is slightly finer. The B horizon is massive or subangular blocky. Thin clay films appear on ped faces and in pores and range from few to common. Consistence is hard to very hard when dry and slightly sticky to sticky and nonplastic to slightly plastic when wet. The reaction ranges from slightly acid to mildly alkaline.

The C horizon is generally similar to the B horizon in color but it is generally somewhat browner or paler colored, particularly where the hue is 7.5YR. The texture ranges from coarse sandy loam to sandy loam. The horizon is normally permeable to a depth of more than 72 inches. In some areas the soil material rests on unrelated, weakly cemented, slowly permeable sandy material or on gravel at a depth of 2 to 6 feet.

Greenfield sandy loam, 0 to 3 percent slopes (GfA).—A profile of this soil is described as representative of the series. This soil is well drained. Runoff is slow, and most surface water drains away through the soil. The available water holding capacity is moderate to high, and the hazard of erosion is slight to none.

Some small areas of Ramona and Hanford soils were included with this soil in mapping.

Under irrigation, this soil is used for raisin grapes, table grapes, and wine grapes, as well as for peaches and plums. Orange groves have been established in the soil near the foothills. Some areas are planted to alfalfa and cotton. Nitrogen fertilizers are used on the vineyard and tree crops. Phosphorus and, in some places, sulfur are used for alfalfa. Cotton yields are maintained by use of both nitrogen and phosphorus fertilizers as well as potassium fertilizers. Irrigation water is applied in furrows, except in areas used for alfalfa, which is irrigated between border checks or by sprinklers. Low-set, low-volume sprinklers are used for some orange groves. The vineyards and tree crops need chemical dusts or sprays to control various pests or diseases. The areas in the foothill valleys are unirrigated and are used for grazing, improved pasture, or dryfarmed grain cut for hay. Capability unit I–1

(17, 18); range site not assigned; natural land type A1; Storie index rating 90.

Greenfield coarse sandy loam, 0 to 3 percent slopes (GsA).—The profile of this soil is similar to that of Greenfield sandy loam, 0 to 3 percent slopes, except that it has a somewhat coarser textured surface layer. In addition, there is a greater proportion of coarse and very coarse sand particles in the subsoil and in the parent alluvium beneath. This is reflected in low to moderate available water holding capacity.

The soil is in many sinuous areas in the vicinity of Reedley, Orange Cove, Sanger, Clovis, and Fresno. It does not occur in the foothill valleys.

The use and management of this soil under irrigation are similar to those of Greenfield sandy loam, 0 to 3 percent slopes, but the irrigation frequency must be increased to maintain optimum moisture for growing plants. The soil is also used for growing watermelons. Capability unit IIs-4 (17); range site not assigned; natural land type A5; Storie index rating 81.

Greenfield sandy loam, 3 to 9 percent slopes (GlB).—This gently to moderately sloping soil occupies short fans or beveled alluvial benches in some foothill valleys. It also occupies short fans along the edge of the foothills and along the bluffs of the secondary valley cut by the San Joaquin River. Runoff is medium, and the hazard of erosion is slight to moderate.

This soil is in small areas near Pinedale, Ft. Washington Beach, Academy, Citrus Cove, Navelencia, and Orange Cove.

Much of this soil is used for dry pasture, and some is used for dryfarmed barley. Along the edge of the foothills, where irrigation water is available, the soil is used for early tomatoes. The sloping position of the soil provides good air drainage and a relatively low frost hazard. The tomatoes are started under hotcaps in the early spring. These same sites are suitable for citrus crops but are limited in extent. Capability unit IIe-1 (17); range site not assigned; natural land type A1; Storie index rating 81.

Greenfield sandy loam, moderately deep, 0 to 3 percent slopes (GuA).—The profile of this soil differs from that of Greenfield sandy loam, 0 to 3 percent slopes, in that it overlies an unrelated, thick, compact, weakly cemented sandy layer at a depth ranging from 24 to 48 inches. The weakly cemented layer seriously impedes deeper root penetration and slows internal drainage. There are deep, widely spaced cracks in some places. Available water capacity is low to moderate.

Included with this soil in mapping were small areas of a similar soil that is moderately sloping or that has a surface layer of coarse sandy loam or fine sandy loam. Also included, within the urban areas of Fresno and Clovis, was a small area of similar soils that overlie the compact material at a depth ranging from 4½ to 6 feet.

This soil is used for vineyards, cotton, alfalfa, irrigated pasture, and some tree fruits, particularly plums. Orange groves have been planted on areas of the soil near the edge of the foothills. The soil is not ideally suited to peaches or other tree fruits, because of the restricted drainage. Ripping can deepen the soil somewhat but generally does not overcome the restriction completely. The ripping tool tends to groove rather than shatter the compact material. Care in irrigation is required so as not to establish a perched zone of saturation for long periods above the substratum. This can bring about sour-sap in peaches and may tend to restrict the effective rooting zone of the soil. The general management for the irrigated crops is similar in other respects to that for Greenfield sandy loam, 0 to 3 percent slopes. The few small areas of this soil that are located along streams in the low foothills are used for grazing. Capability unit IIIs-3 (17); range site not assigned; natural land type A9; Storie index rating 67.

Hanford Series

The Hanford series consists of well-drained, fertile, moderately coarse textured soils formed in recent granitic alluvium. These soils lack a subsoil, but they are some of the best soils for farming in the survey area. The Hanford soils formed mainly on nearly level, broad alluvial fans. In some areas they formed on alluvial benches in the secondary river valleys and also in gently sloping alluvial fans.

The largest acreage of these soils is on the upper parts of the young fans along both the Kings River and the San Joaquin River. Large acreages are also on fans and flood plains of small streams between Clovis and Sanger, as well as in the Reedley-Orange Cove district. The soils are mainly at elevations of 200 to 500 feet, but some are at higher elevations in the lower foothill valleys. The average annual rainfall ranges from 8 to 16 inches, the average annual temperature is about 62° F., and the average growing season ranges from 250 to 275 days. The natural vegetation was probably annual grasses and forbs, similar to those growing in a few idle areas and in areas of the soil in the lower foothill valleys.

A typical profile has a light brownish-gray, neutral fine sandy loam surface layer about 16 inches thick. The surface layer overlies a thick, pale-brown, neutral to mildly alkaline layer of fine sandy loam that is noncalcareous. The content of organic matter is low in the surface layer.

Nearly all of the acreage of these soils is cultivated. Under irrigation, these soils are suited to many kinds of climatically adapted field, fruit, forage, and truck crops. Good quality water is available from irrigation canals or from wells. The water table stands at a depth ranging from 30 to 75 feet.

Representative profile in fallow on the nearly level young alluvial fan of the Kings River, at an elevation of 350 feet. (About 1 mile E. of the town of Parlier near the intersection of Manning and Smith Avenues; 100 feet SSW. of the NE. corner of sec. 30, T. 15 S., R. 23 E.).

Ap1—0 to 7 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; cloddy; hard when dry, friable when moist, very slightly sticky and nonplastic when wet; very

few very fine roots, few fine and very fine tubular pores; neutral (pH 7.0); abrupt, wavy lower boundary

Ap2—7 to 16 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist, massive; very hard when dry (tillage pan), friable when moist, very slightly sticky and nonplastic when wet; very few fine and very fine roots, few fine tubular pores, common micro interstitial pores; neutral (pH 7.0); clear, wavy lower boundary.

C1—16 to 44 inches, pale-brown (10YR 6/3) fine sandy loam, dark brown to yellowish brown (10YR 4/3 to 5/4) when moist; massive; very slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; very few fine roots, few fine and medium tubular pores, many fine interstitial pores, occasional small lenses of medium sand; neutral (pH 7.0); diffuse, smooth lower boundary

C2—44 to 72 inches, very pale brown (10YR 7/3) fine sandy loam, dark yellowish brown (10YR 4/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; very few fine and medium roots; very few fine and medium tubular pores, many fine interstitial pores: mildly alkaline (pH 7.5)

The A horizon is dominantly light brownish gray but ranges in places to pale brown, brown, or grayish brown. The hue is 10YR, the value is 6 or, in places, 5; and the chroma is 2 or 3. When moist, the horizon appears dark brown or dark grayish brown. The hue generally is the same but changes to 7.5YR in places. Moist value is only 3 or 4, and chroma shows little or no change. The A horizon is generally massive but in places has weak granular structure. The texture is coarse sandy loam, sandy loam, gravelly sandy loam, fine sandy loam, or loam. Consistence ranges from slightly hard to hard when dry, very friable to friable when moist, nonsticky to slightly sticky and nonplastic to slightly plastic when wet. The reaction ranges from slightly acid to mildly alkaline.

The C horizon is massive and similar in consistence to the A horizon. It is stratified in places and ranges in texture from coarse sandy loam to fine sandy loam or light loam, including some gravelly sandy loam. Dry color is commonly pale brown or very pale brown but is brown or yellowish brown in places. The hue is 10YR, the chroma is 3 or 4, and the value is 5 to [illegible]. Moist color is brown, yellowish brown or dark yellowish brown. The hue and chroma remain the same, but the value is 4 and 5. The reaction ranges from neutral to mildly alkaline and the horizon is noncalcareous.

These soils are commonly underlain by unrelated layers of gravel, sand, and a compact substratum of silty or sandy material at a depth ranging from 2 to 6 feet. In a few places they overlie older soils at a depth of about 2 feet.

Hanford fine sandy loam (0 to 2 percent slopes) (Hm).—A profile of this soil is described as typical for the series. The texture of the surface layer is dominantly fine sandy loam, but in small inclusions it is loamy fine sand. The surface layer ranges from about 8 to 18 inches in thickness. Surface crusting and tillage compaction in varying degrees is common. The underlying material is uniformly fine sandy loam. A few very deep auger borings and well logs indicate that silty material may be encountered at a depth of more than 6 feet in the young fans of the rivers. This is very unlikely where the soil has formed in recent alluvium from the smaller streams. Most of this nearly level soil is located on the smoother upper parts of the young fans along the rivers

The permeability of this soil is moderately rapid except where slowed by tillage compaction. Runoff is slow. The available water holding capacity is high. The hazard of erosion is slight to none.

Included with this soil in mapping was a small area of similar soil having a loam surface layer. This soil formed in the alluvium of some small creeks in the vicinity of Clovis, Fresno, and Kearney Park. The underlying material consists of light loam and fine sandy loam. Also included was a very small area of similar soils that are gently to moderately sloping. This inclusion occupies beveled alluvial benches in the vicinity of Reedley.

Hanford fine sandy loam is used principally for raisin grapes, peaches, and plums. Table and wine grapes are also grown, as well as some walnuts. A fairly sizable acreage is used for alfalfa and cotton. A small area is used for vegetables and melons. Areas of the soil in foothill valleys are used for grazing or dry pasture.

The most serious limitation is the tendency of the soil to compact and form tillage pans. Wheeled vehicles also contribute to the formation of compact layers near the surface. These layers can significantly slow the infiltration of surface water, making effective irrigation more troublesome. Greater care is needed to see that lower rooting zones are not permitted to dry out because of insufficient time being allowed for waters to penetrate. Chiseling at variable depths breaks up the compacted layers. This may alleviate the problem temporarily. Deep chiseling, or subsoiling, is not done in orchards, because of the likelihood of tree root damage. Chiseling along vine rows is generally held to the center of the avenues for the same reason. Cover crops of grasses, principally barley, or barley and vetch, are used in vineyards and orchards. The fine root systems tend to improve the porosity somewhat.

Fertilizers are used with all crops. Nitrogen alone is used on the tree-fruit crops. Nitrogen and, in places, phosphorus and potassium are used for the grapes. Nitrogen is used in places to stimulate seedling growth of alfalfa, which also responds to sulfur. Cotton requires both nitrogen and phosphorus and is showing an increasing need for potassium. Capability unit I-1 (17, 18); range site not assigned; natural land type A1; Storie index rating 100.

Hanford coarse sandy loam (0 to 2 percent slopes) (Ha).—This soil is similar to Hanford fine sandy loam, except that it is coarse sandy loam throughout. Areas of the soil are commonly long and winding, indicating its formation in aggraded channels of many former flood distributaries. The soil is widely scattered throughout the valley on recent and young fans of rivers and streams

Because of the coarser texture of the soil, its available water holding capacity is somewhat less than that of Hanford fine sandy loam. For comparable crops and conditions, a somewhat greater frequency of irrigation is needed than for Hanford fine sandy loam.

Most of the acreage of Hanford coarse sandy loam is used for vineyards. Raisin grapes, table grapes, and wine grapes are all grown on the soil. Raisin grapes are dominant. The incidence of root-knot nema-

todes in this and sandier soils make this soil not well suited to peaches. Some plums are grown. Cotton, corn, grain sorghum, and sugar beets are also grown on the soil, particularly in the western parts of its extent. In the Reedley-Orange Cove area, some tracts of the soil are used for watermelons. The soil is suited to citrus groves near the foothills where the frost hazard is lowest. Capability unit IIs-4 (17); range site not assigned; natural land type A5; Storie index rating 80.

Hanford coarse sandy loam, hard substratum (0 to 2 percent slopes) (Hb).—This soil is similar to Hanford fine sandy loam, except that it is coarse sandy loam in the upper part of the profile. At a depth of 2½ to 3 feet is a thick, compact, weakly cemented sandy layer. In places the depth to this layer is as little as 1 foot or as much as 5 feet.

The compact material is composed of older granitic alluvium not directly related to the overlying soil. It is massive and slowly to very slowly permeable, thus restricting internal drainage. Root growth is limited; consequently, the available water holding capacity of the soil is low.

This soil is mainly in the vicinity of Kerman. A few areas are near Reedley and on small fans in some foothill valleys. Included with this soil, east of Friant and near Dunlap, were two small areas of similar soils that are gently sloping.

This soil is used mainly for raisin grapes, irrigated pasture, and alfalfa. The small areas in the foothill valleys are used for grazing and for dryfarmed grain cut for hay. Care is needed in irrigation where deep-rooted crops are grown, to avoid building up a prolonged, perched zone of saturation above the compact layer. Capability unit IIIs-8 (17); range site not assigned; natural land type A11; Storie index rating 48.

Hanford fine sandy loam, clay loam substratum (0 to 2 percent slopes) (Hp).—This soil is similar to Hanford fine sandy loam except it formed in about 3 feet of alluvium overlying a Ramona soil. Most of the original surface layer of the Ramona soil appears to have been eroded away before the younger alluvium was laid down. The alluvium lies abruptly on reddish-brown clay loam or sandy clay loam that is typical of the subsoil in the Ramona soils (see the description under the Ramona series). The internal drainage of this soil is slowed, but not seriously impeded, by the buried soil. The surface layer is loam in small areas included in mapping.

The soil is on the outer edge of the Dry Creek fan, northwest of Clovis, where it adjoins older terraces made up of San Joaquin and Ramona soils.

All the acreage of this soil is under irrigation and is used for cotton, alfalfa, peaches, and plums. Care should be taken to check the moisture in the surface layer to plow depth before cultivating to avoid puddling or compaction. The soil tends to hold more water and drains somewhat more slowly than Hanford fine sandy loam. Capability unit I-1 (17, 18); range site not assigned; natural land type A2; Storie index rating 90.

Hanford fine sandy loam, gravelly substratum (0 to 2 percent slopes) (Hn).—A thick layer of loose gravel and cobblestones underlies this soil at a depth ranging from 3½ to 8½ feet. Except for this layer, this soil is similar to Hanford fine sandy loam.

The very coarse layer tends to impede internal drainage somewhat. Slight mottling can be seen in places in the underlying material a few inches above the contact with the gravel. This is a reflection of the saturated zone that develops at the contact when excess water drains through the profile. The thickness of the zone that forms is a measure of the pressure, or head of water, needed to move excess water across the contact and into the gravel. The water that may accumulate above the gravel is removed mainly by evaporation or through transpiration by plants. The limited soil depth above the gravel reduces the available water holding capacity to moderate.

Most of the acreage is on an alluvial bench on the east side of the Sanger bottom lands between Minkler and Wahtoke. Other areas are near Centerville and Pine Flat Dam, in Tivy Valley, along Fancher Creek, and south of Friant along the San Joaquin River. Some narrow stringers and areas of gravelly or cobbly Hanford soils have been included with this soil. In places the depth to the gravelly layer is as shallow as 1½ feet; in others it is as deep as 5 feet.

The soil is used mainly for vineyards, particularly for table or wine grapes. Irrigation of this soil should be managed so as to minimize the development of a perched zone of saturation above the gravel. Fertilizer needs are similar to those of Hanford fine sandy loam. Capability unit IIs-0 (17); range site not assigned; natural land type A1 1f; Storie index rating 76.

Hanford fine sandy loam, hard substratum (0 to 2 percent slopes) (Hr).—The profile of this soil is similar to Hanford fine sandy loam, but it has an unrelated, compact, weakly cemented, sandy layer, several feet thick, at a depth ranging from about 2½ to 4 feet. This reduces the available moisture capacity to low values. In places this layer lies at a depth of 4½ to 5 feet. It is slowly permeable and restricts the internal drainage of the soil. A perched zone of saturation can develop in the soil when water in excess of the field capacity of the soil drains into it. However, under natural conditions, excess water drains away quickly enough that somewhat poor or poor drainage does not develop in the lower part of the underlying material.

The soil is on the young fans of the rivers and recent fans along certain smaller streams, generally bordering or near areas of older alluvial terraces. The hard layer represents eroded parts of the terrace deposits which have been buried by more recent alluvium in which the Hanford soil formed. Areas of this soil are near Orange Cove, Reedley, Parlier, Centerville, Del Rey, Clovis, Fresno, and Herndon, as well as in some foothill valleys. Included with this soil in mapping was a small area near Minkler in which the underlying material consists of Porterville clay.

Hanford fine sandy loam, hard substratum, is used mainly for raisin, table, and wine grapes. Some cotton and alfalfa are also grown. The soil is well suited to permanent pasture. Corn, grain sorghum, irrigated barley, and sugar beets also do well on this soil, but little

acreage is left over from the vineyards to grow these crops. Few peaches and plums are grown on the soil. They are not well suited, because of the shallowness of the soil and the slow drainage once saturation zones are established. Fertilization requirements are similar to those for Hanford fine sandy loam. Amounts and frequencies of application of irrigation water should be governed by the hazard of forming a perched zone of saturation. The soil can be deepened, particularly in shallower areas, by ripping. It is not economically feasible to completely break up and remove the hard layer that restricts drainage. Capability unit IIIs-3 (17); range site not assigned; natural land type A9; Storie index rating 75.

Hanford fine sandy loam, silty substratum (0 to 2 percent slopes) (Ho).—The profile of this soil is similar to Hanford fine sandy loam, but it has a compact, light-gray, silty layer, mainly at a depth of about 3 to 3½ feet. In places the depth is less than 2 feet or more than 4 feet. The available water capacity is moderate.

The contact between the overlying layers and the silty layer may be smooth, very irregular, or broken. The texture of the material above the silty layer is uniformly fine sandy loam. Dry color of the surface layer is generally pale, ranging from light brownish gray to very pale brown. The dry color of the underlying material is pale brown. Locally, this soil has been called the white-ash lands.

In many places the underlying silty material is broken by vertical cracks or filled burrows of animals or insects. It provides only a mild restriction to internal drainage, and many roots can grow into the cracks and filled burrows. Many yellowish-brown mottles in parts of the silty layer indicate a past history of a fluctuating water table at about the depth of this layer.

The soil is in large irregular areas on the higher parts of the young fans along both the Kings River and the San Joaquin River.

This soil produces well and responds favorably to good management. It is used extensively for raisin grapes, peaches and plums, and some walnuts. Alfalfa and cotton are grown on this soil, particularly in the western parts of its distribution. The soil is well suited to many other crops such as irrigated barley, corn, grain sorghum, truck crops, berries, melons, and sugar beets. The management of this soil is similar to that of Hanford fine sandy loam. Distinct symptoms of potassium deficiency were first noted on cotton in this soil. The symptoms are correctable by additions of large amounts of potassium fertilizer early in the growing season. Capability unit IIs-3 (17); range site not assigned; natural land type A2; Storie index rating 95.

Hanford gravelly sandy loam (0 to 2 percent slopes) (Hl).—This soil is similar to Hanford fine sandy loam, except that it has a gravelly sandy loam surface layer and variably stratified underlying material. The underlying material is moderately coarse textured and generally gravelly but contains random, nongravelly lenses or layers in many places. The available water capacity of this soil is moderate.

The soil is mainly on the floor of the entrenched valley cut by the San Joaquin River, southwest of Friant. Areas of the soil are also near Herndon and Biola and in the foothills near Dunlap.

A small area of a similar soil that is gently sloping was included with this soil in mapping. It occupies erosionally beveled edges of alluvial benches or terraces.

Hanford gravelly sandy loam is used mainly for growing raisin and table grapes, alfalfa, and irrigated pasture. Some areas of the soil are idle. Others are used for grazing or dry pasture, and some have been developed for public picnic sites along the San Joaquin River. The use of fertilizers for the irrigated crops is similar to that of Hanford fine sandy loam. Because of the lower water-holding capacity, more frequent irrigations are required. Capability unit IIs-4 (17); range site not assigned; natural land type A7; Storie index rating 70.

Hanford sandy loam (0 to 2 percent slopes) (Hc).—This soil is sandy loam throughout, but otherwise it is similar to Hanford fine sandy loam. Because of the coarser texture, the available water holding capacity is moderate, slightly lower than that of Hanford fine sandy loam. This soil ranges in color from brown to pale brown or very pale brown. The paler colors are consistently associated with those areas of the soil that overlie a light-gray silty layer at a depth of more than 4 feet and generally more than 5 feet.

Included with this soil in mapping was a minor area of a similar soil having relict mottles in the underlying material, which reflect a past history of somewhat poorer drainage. The surface layer of the included soil is dark brown or grayish brown. The included soil is distributed over the young fan of the Kings River in small, commonly winding areas occupying the bottoms of former distributary flood channels. In some places it occupies wind-scoured hollows away from the channels.

The use and management of Hanford sandy loam are similar to those of Hanford fine sandy loam. Somewhat more frequent irrigations are generally required for field crops. Capability unit IIs-4 (17); range site not assigned; natural land type A1; Storie index rating 95.

Hanford sandy loam, benches (Hd).—This gently to moderately sloping soil is like Hanford fine sandy loam except that it is sandy loam throughout the profile. It occupies beveled alluvial benches and sloping small fans. Slope ranges from 3 to 9 percent. The runoff is medium, the erosion hazard is slight to moderate, and the available water capacity is moderate.

The soil is located in the entrenched valley of the San Joaquin River, on banks of some distributary channels on the young fan of the Kings River, and on small sloping fans along the edge of the foothills and in some foothill valleys. A minor area of the soil near Dunlap shows slight sheet erosion and is cut by a few widely spaced gullies.

The soil is used for some raisin grapes. Irrigation is done on the contour. Along the San Joaquin River, there are some areas in alfalfa or irrigated pasture and others that are idle. Fertilizer requirements for irrigated crops

are similar to the requirements of Hanford fine sandy loam. In the foothill valleys, the soil is used for grazing. Capability unit IIe-1 (17); range site not assigned; natural land type A1; Storie index rating 86.

Hanford sandy loam, clay loam substratum (0 to 2 percent slopes) (Hh).—This soil is sandy loam to a depth of about 3 feet. It formed in about 3 feet of alluvium that is underlain by reddish brown clay loam or sandy clay loam, which resembles the subsoil of a typical Ramona soil.

This Hanford soil is located on the western edge of Dry Creek fan, northwest of Clovis. Its use and management are similar to those of Hanford fine sandy loam, clay loam substratum, but its available moisture holding capacity is moderate. Capability unit IIs-4 (17); range site not assigned; natural land type A2; Storie index rating 86.

Hanford sandy loam, gravelly substratum (0 to 2 percent slopes) (He).—This soil has a profile that is similar to that of Hanford fine sandy loam, but is sandy loam to a depth of 2½ to 3 feet. It is underlain by a thick layer of loose gravel and cobblestones. The available water holding capacity is low to moderate.

This soil is mainly on slightly elevated alluvial benches in the secondary valleys of both the Kings River and the San Joaquin River.

Included with this soil in mapping, southwest of Friant, were areas of a similar soil having a gravelly sandy loam surface layer. Other inclusions consist of very gravelly spots or streaks and some minor areas of soils that have a slight accumulation of clay in the soil layer just above the gravel. The latter included soils are mainly south of Friant along small streams tributary to Little Dry Creek.

Hanford sandy loam, gravelly substratum, is used mainly for vineyards; table or wine grapes are well suited. Some peach orchards have been successfully established on this soil, and northeast of Centerville fairly extensive orange groves are doing well. The interface contact between soil and gravel is not abrupt; consequently, there is less tendency for a saturated zone to develop within the rooting zone from excess water draining into the soil. Near Friant, the soil is idle, or is used for alfalfa, irrigated pasture, or for grazing in association with soils on upland terraces used for range. The fertilizer needs of the irrigated soil are similar to those for Hanford fine sandy loam. Frequent irrigations are needed. Capability unit IIs-0 (17); range site not assigned; natural land type A1-1f; Storie index rating 78.

Hanford sandy loam, hard substratum (0 to 2 percent slopes) (Hk).—This soil has a profile that is similar to that of Hanford fine sandy loam. It is sandy loam above a depth of 2½ to 4 feet. Below that depth is an unrelated, compact, weakly cemented, sandy layer several feet thick. The underlying material is occasionally stratified with layers of coarse sandy loam and fine sandy loam. The available water capacity is low.

Included with this soil in mapping were minor areas near Smith Mountain and west of Kingsburg in which depth to the compact layer ranges from 1 to 2 feet. Some areas of the soil, near Fresno, Smith Mountain, and Kearney Park, are 4 to 5 feet deep to the hard layer in places. A very small included area of Hanford sandy loam near Wahtoke is underlain by dense clay rather than a hard layer.

The use and management of Hanford sandy loam, hard substratum, are similar to those of Hanford fine sandy loam, hard substratum. Capability unit IIIs-3 (17); range site not assigned; natural land type A9; Storie index rating 71.

Hanford sandy loam, sandy substratum (0 to 2 percent slopes) (Hf).—This soil has a profile that is similar to that of Hanford fine sandy loam. In this soil the surface layer and the layer just below it are sandy loam. These layers overlie a thick, loose layer of sand at a depth ranging from 2 to 2½ feet. In places the depth is as shallow as 1½ feet or as deep as 3 feet. The contact between the sandy loam and the sand tends to restrict internal drainage unless the soil material above is saturated to a sufficient depth to force water into the more open sandy layer. Roots do not penetrate and grow in the sand layer to any great extent. The available water holding capacity of this soil is low.

This soil is on the Fresno State College farm, in the vicinity of Clovis, west of Kearney Park, and near Piedra and Laton. Small included areas have a surface layer of fine sandy loam.

This soil is best suited to field crops. It is not well suited to tree fruit crops. Grapes do fairly well. Fertilizer needs are similar to those of Hanford fine sandy loam. Irrigation water is best applied frequently in small amounts. Near Piedra an area of this soil is idle or used for some grazing. Capability unit IIIs-4 (17); range site not assigned; natural land type A1-1f; Storie index rating 77.

Hanford sandy loam, silty substratum (0 to 2 percent slopes) (Hg).—The profile of this soil is similar to that of Hanford fine sandy loam but is mainly sandy loam to a depth of about 3 to 3½ feet. Beginning at that depth is a compact, light-gray, silty layer. In a few places this layer is at a depth of less than 2 feet or more than 4 feet. This soil is located on the naturally well-drained parts of the young fans of both the Kings and San Joaquin Rivers. The use and management of the soil are very similar to those of Hanford fine sandy loam. The water-holding capacity of this soil is low to moderate. Capability unit IIs-3 (17); range site not assigned; natural land type A2; Storie index rating 90.

Hesperia Series

The Hesperia series consists of well-drained moderately coarse textured soils that formed in granitic alluvium. These soils have accumulated a slight to moderate amount of lime below the surface layer and in places are saline-alkali affected. They are on the central parts of the young fans of both the Kings River and the San Joaquin River and on local stream ridges on the lower parts of the fans. The surface is smooth and nearly level to gently undulating.

These soils are at elevations of 200 to 400 feet. The average annual precipitation ranges from about 8 to 10 inches, the average annual temperature is 62° F.,

and the average frost-free season ranges from 225 to 250 days. The natural vegetation is presumed to have been mainly annual grasses and forbs, together with saline-alkali tolerant plants in places.

The Hesperia soils typically have a light brownish-gray, neutral fine sandy loam surface layer about 11 inches thick. The lower horizons are very pale brown, mildly to moderately alkaline fine sandy loam to a depth of about 43 inches. Below that depth is light-gray, moderately alkaline, calcareous silt.

The soils formed in material that was only moderately well drained to somewhat poorly drained and had a water table closer to the surface than at present. Through stream control and widespread pumping of ground water for irrigation, the regional water table has been markedly lowered. The general drainage of the soils is now good. Irrigation water is plentiful and of good quality. It is obtained from irrigation district canals that bring water from the Kings River, and from wells tapping the local ground water. Nearly all of the acreage of these soils is cultivated.

Representative profile in a nearly level fallow field, formerly a vineyard, on the young alluvial fan of the Kings River at an elevation of 350 feet (on the Kearney Horticultural Field Station about 1 mile ESE. of the town of Parlier; 200 feet E. of the center of the NE1/4 of sec. 30 T. 15 S., R. 23 E.):

Ap1—0 to 5 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark brownish gray (10YR 4/2) when moist; cloddy, hard when dry, friable when moist, slightly sticky and nonplastic when wet, few very fine roots; very few fine tubular pores; plentiful medium vesicular pores; neutral (pH 7.0); very abrupt, wavy lower boundary.

Ap2—5 to 11 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark brownish gray (10YR 4/2) when moist; massive; hard when dry, friable when moist, slightly sticky and nonplastic when wet, few very fine roots; very few tubular pores; occasional very thin lenses of fine sand; neutral (pH 7.0); gradual, smooth lower boundary.

C1—11 to 32 inches, very pale brown (10YR 7/3) fine sandy loam, dark brown (10YR 4/3) when moist; massive; hard when dry, very friable when moist, slightly sticky and nonplastic when wet; few fine and medium roots; many fine tubular pores, many very fine and microsize interstitial pores; common thin clay films in some tubular pores; mildly alkaline (pH 7.5); clear, irregular lower boundary.

C2ca—32 to 43 inches, very pale brown (10YR 7/3) fine sandy loam, brown (10YR 5/3) when moist; massive; hard when dry, very friable when moist, slightly sticky and nonplastic when wet; very few fine and few medium roots, mostly oriented horizontally; many fine tubular pores; many microsize interstitial pores; common thin clay films in the tubular pores; slightly calcareous, few to common, fine, random lime seams; moderately alkaline (pH 8.0); very abrupt, irregular lower boundary.

IIC3ca—43 to 63 inches, light-gray (5Y 7/2) silt, light brownish gray (2.5Y 6/2) when moist; weak, medium to coarse, platy structure; hard to very hard when dry, firm to friable when moist, nonsticky and nonplastic when wet; few roots following soil-filled small animal burrows; few fine tubular pores with some pore walls colored yellowish red to dark red; few thin lenses of very fine sand; strongly calcareous, many fine lime seams, some pores lime coated, other segregated lime in irregular, soft masses; moderately alkaline (pH 8.0); diffuse, wavy lower boundary.

IIC4—63 to 75 inches +, white (5Y 8/1) silt, light brownish gray (2.5Y 6/2) when moist; weak, medium to very coarse, platy structure; hard to very hard when dry, friable to firm when moist, nonsticky and nonplastic when wet; few roots of any size in soil-filled animal burrows; few fine tubular pores with fine prominent mottles of yellowish red or dark red on the pore walls; few thin lenses of very fine sand; intermittently and weakly calcareous; moderately alkaline (pH 8.0).

The A horizon is typically light colored, ranging from pale brown or light brownish gray to very pale brown or light gray. The hue is generally 10YR but is 2.5Y in places. Value is 6 or 7, and chroma is 2 or 3. Moist colors are somewhat darker, ranging from brown or dark brown to dark grayish brown and in places dark yellowish brown. When the horizon is moist the hues do not change, but the value is only 4 or 5 and the chroma brightens slightly or remains the same, ranging from 2 to 4. Texture of the A horizon ranges from coarse sandy loam to loam. The A horizon is generally massive; in places a thin vesicular layer develops at the surface. The A horizon is cloddy or granular under cultivation. The consistence ranges from soft to hard when dry, friable to very friable when moist, and slightly sticky or nonsticky when wet. Reaction generally ranges from slightly acid to mildly alkaline; it is strongly alkaline in some saline-alkali affected areas.

The C horizon is similar to the A horizon in color, lack of structure, and consistence. It is also similar in texture; there is little or no stratification in the profile above the IIC horizon, or in the absence of a IIC horizon. The C horizon ranges from mildly to strongly alkaline and is variably calcareous. The C1 horizon is calcareous in some places but not in others. The lime is generally disseminated but also occurs as tiny threads. Where there is a IIC horizon, it is generally 30 to 48 inches below the surface, but in places it is as shallow as 12 inches. Its upper boundary is generally abrupt, but ranges in its relief from smooth to irregular, or broken. In places there is intercalation of thin layers of coarser alluvium with the silt. The thickness of the lime accumulation zone within the IIC horizon varies greatly from place to place. It is seldom thinner than described.

Hesperia fine sandy loam, moderately deep (0 to 2 percent slopes) (Hst).—The profile of this soil is like the one described as typical for the series. The texture of this soil in the surface layer and underlying material is mainly fine sandy loam, but it is very fine sandy loam in small areas. The surface layer is neutral to mildly alkaline, and the underlying material is mildly to moderately alkaline. The zone of lime accumulation varies greatly in thickness. In many places the lower limit of significant lime accumulation occurs below a depth of 6 feet.

The soil is moderately permeable. The permeability of an undisturbed part of the underlying material is moderately slow. However, this material as a whole offers only a slight restriction to internal drainage because it is broken in places or because of the presence of burrows in the material. Roots are able to penetrate deeply through the cracks and filled burrows. Runoff is slow, and the hazard of erosion is slight to none. The available water holding capacity is moderate to high; it is possibly related to a relatively high silt content in the soil.

This soil is mainly on the central part of the young fan of the Kings River, but some areas are on the young fan of the San Joaquin River. All the acreage has been smoothed or leveled and converted to cropland.

Included with this soil in mapping was a minor

area of a similar soil that is loam in texture and more brown in color. Also included were areas of a similar soil that has been fully reclaimed. These are mainly near or along the western limit of the soils in the survey area, close to the basin rim zone.

Hesperia fine sandy loam, moderately deep, is suited to most crops adapted to the climate of the area. With good management, raisin and table grapes, peaches, plums, walnuts, alfalfa, irrigated barley, corn, cotton, grain sorghum, irrigated pasture, and sugar beets are grown successfully. Most of the soil is used for vineyards and for cotton followed by alfalfa. The acreage in sugar beets is increasing. According to the crop grown, irrigation is mainly through furrows or between border checks. The soil is generally leveled and planed to control surface water applications. The moderate to high available water holding capacity permits longer periods between irrigations compared to nearby sandier soils. Nitrogen and phosphorus are needed by most field crops. Cotton is improved by potassium fertilizers. Alfalfa and legumes in pasture mixes are stimulated by sulfur. In places areas of this soil, presumably reclaimed, have remnant accumulations of salts and sodium in the substratum. Long-range water management should avoid local buildup of the water table to the point where the salts can move back into the soil. Capability unit IIs-8 (17); range site not assigned; natural land type A2; Storie index rating 95.

Hesperia coarse sandy loam (0 to 2 percent slopes) (Hsa).—The profile of this soil is similar to that of Hesperia fine sandy loam, moderately deep, but it is coarse sandy loam in the surface layer and underlying material and lacks a compact, silty layer or any restricting layer within a depth of 6 feet. Because of its coarser texture, this soil has moderately rapid permeability and has a low to moderate available water holding capacity. This soil occupies many winding areas in aggraded and abandoned stream channels on the lower, western part of the young fan along the San Joaquin River between Whites Bridge and Kerman. Many areas are associated with saline-alkali soils in the basin rim zone.

Cotton, alfalfa, grain sorghum, sugar beets, and irrigated pasture are the crops generally grown on this soil. Some areas of the soil are undeveloped and used only for grazing. In many places it is not practical to meet the specific irrigation needs of the soil because of the narrow shapes of the areas. Consequently, crops grown in areas of this soil in association with other finer textured soils are somewhat lacking in sufficient moisture and optimum growth is not obtained. Fertilizer needs of this soil are similar to those of Hesperia fine sandy loam, moderately deep. Capability unit IIs-4 (17); range site not assigned; natural land type A5; Storie index rating 80.

Hesperia coarse sandy loam, saline-alkali (0 to 2 percent slopes) (Hsc).—The profile of this soil differs from that of Hesperia fine sandy loam, moderately deep, in that it has coarse sandy loam surface and subsurface layers, lacks underlying silty material, and is strongly alkaline where there is some accumulation of salts. This condition is from a former time when the natural water table was much closer to the surface. Because of regional lowering of the water table through pumping and flood control, the soil is now well drained. The present water table lies at a depth ranging from 30 to 50 feet. The available water holding capacity is low to moderate.

The soil is in long, winding areas similar in position and location to those of Hesperia coarse sandy loam. Most areas of this soil, however, occupy somewhat more depressed channelways.

Most of the acreage lies in undeveloped areas of saline-alkali soils and is used in conjunction with them for alkali pasture. The moderately rapid permeability of the soil makes it quickly reclaimable from its saline-alkali condition, principally through leaching alone. As the job of reclaiming the saline-alkali soil progresses in the basin rim zone, this soil will soon be used in the same way as Hesperia coarse sandy loam. District or regional water management must avoid raising the water table to the extent that this soil and other reclaimable saline or saline-alkali soils return to their less productive original state. Capability unit IIs-6 (17); range site not assigned; natural land type A5-2s; Storie index rating 64.

Hesperia fine sandy loam (0 to 2 percent slopes) (Hs).—The profile of this soil resembles that of Hesperia fine sandy loam, moderately deep, described as typical for the series, but it is deeper to an underlying silty layer. This layer is at a depth of generally more than 4½ to 5 feet, and it has little effect on the growth of crops on this soil.

This soil is located mainly on the middle part of the young fan of the Kings River. The number of areas decreases rapidly on the higher parts of the fan.

Included with this soil was a small area of a soil similar to this one but that is brown in the surface layer and underlying material and lacks a silty layer within 6 feet of the surface. Most of the areas of the included soil have a loam surface layer and are located near Kearney Park. The parent alluvium for the included soil was deposited mainly by Fancher Creek. It is somewhat mixed with materials from other than granitic rocks.

The use and management of this soil are similar to those for Hesperia fine sandy loam, moderately deep. This soil, however, provides a more unrestricted root zone for deep-rooted crops. Capability unit I-1 (17, 18); range site not assigned; natural land type A1; Storie index rating 100.

Hesperia fine sandy loam, saline-alkali (0 to 2 percent slopes) (Hss).—The profile of this soil is similar to that of Hesperia fine sandy loam, moderately deep, but it has a silty layer at a greater depth and is saline-alkali affected. The underlying material is strongly alkaline and generally at least slightly saline from salt accumulations. About one-half of the acreage shows no evidence that the surface layer is affected. The rest of the acreage shows such effects in the surface layer in the form of bare spots or areas of depressed plant growth. These bare and sparsely vegetated areas make up 5 to 66 percent of the surface area.

This soil is in small areas on the lower parts of the young fan of the Kings River. Most areas of the

soil lie along the upper margin of the basin rim zone in the vicinity of Laton, Riverdale, Caruthers, and Raisin City. Some areas are located near Selma and Easton.

Unless the salts and alkali are removed, this unit is not suited to irrigated crops, except irrigated pasture. Irrigated pasture can be established on this soil, particularly in areas that are not saline-alkali affected in the surface layer. The continued use as irrigated pasture tends to further the reclamation of the soil. Undeveloped areas are used for alkali pasture. Reclaimed or partly reclaimed areas of the soil are used for alfalfa and cotton as well as for irrigated pasture. The management for alfalfa and cotton is similar to that for Hesperia fine sandy loam, moderately deep. Long-term water and crop management should guard against the return of saline-alkali conditions once the soil is reclaimed. Capability unit IIs-6 (17); range site not assigned; natural land type A1-2s; Storie index rating 60.

Hesperia fine sandy loam, moderately deep, saline-alkali (0 to 2 percent slopes) (Hsy).—The profile of this soil is similar to that of Hesperia fine sandy loam, moderately deep, but is saline-alkali affected. The fine sandy loam underlying material and, in many places, the silty layer below it are strongly alkaline and generally at least slightly saline from salt accumulations. About two-thirds of the acreage, at the time of mapping, showed surface effects of excess salts and alkali on 5 to 33 percent of the surface area. About one-tenth of the acreage showed no surface effects, and the rest showed effects on more than 33 percent of the surface area.

The soil is distributed in areas of varying sizes, mainly adjacent to the basin rim zone on the young fans of both the Kings and San Joaquin Rivers. Most of the soil lies between Kingsburg and Kerman. Some small areas are scattered higher on the fans near, but generally west of Easton, Malaga, Fowler, Selma, and Kearney Park.

Without irrigation, undeveloped areas of the soil are used for alkali pasture. With irrigation but without reclamation, few crops can be profitably grown on the soil except irrigated pasture. With reclamation, irrigated field crops such as alfalfa, cotton, barley, grain sorghum, corn, and sugar beets can be grown successfully. Reclamation requires well-planned operations. These are discussed in the section "Saline and Saline-Alkali Soils." Continued successful cropping of this soil after reclamation requires that care be taken to avoid return of the excess salts and alkali. The underlying silty layer commonly remains saline-alkali long after the soil material above is effectively reclaimed, discouraging its penetration by deep roots. Other management requirements are similar to those of Hesperia fine sandy loam, moderately deep. Capability unit IIIs-6 (17); range site not assigned; natural land type A2-2s; Storie index rating 57.

Hesperia sandy loam (0 to 2 percent slopes) (Hsd).—The profile of this soil is similar to that of Hesperia fine sandy loam, moderately deep, but it is sandy loam above the silt layer. In addition, the depth to silt layer averages about 5 feet and ranges from 4 to 6 feet. The available water holding capacity for the soil is moderate.

The soil is mainly on the central and lower parts of the young fan of the Kings River. Included in the unit, and comprising about 10 percent of the total area, are areas of a similar soil in which the silt layer is lacking or occurs well below a depth of 6 feet.

The use and management of Hesperia sandy loam are similar to those of Hesperia fine sandy loam, moderately deep. Somewhat more frequent irrigation is needed for Hesperia sandy loam than for Hesperia fine sandy loam, moderately deep, to keep the rooting zone at optimum moisture content. Capability unit IIs-4 (17); range site not assigned; natural land type A1; Storie index rating 95.

Hesperia sandy loam, saline-alkali (0 to 2 percent slopes) (Hse).—The profile of this soil is similar to that of Hesperia fine sandy loam, moderately deep, but is sandy loam to a depth of more than 4 feet and is saline-alkali affected. Only about one-fourth of the acreage has a silty layer at a depth of 4 to 6 feet. Most of the acreage is without a silty layer and is saline-alkali affected only in the material below the surface layer.

The soil is mainly in the basin rim zone of the young fans of Kings River and San Joaquin River. Most of the unit acreage lies in long, winding areas formed in aggraded flood distributary channels.

Most of the soil is readily reclaimable. The available water holding capacity after reclamation is moderate. Unreclaimed, undeveloped areas of the soil are used as alkali pastures. Reclaimed and irrigated areas are used mainly for cotton, alfalfa, and grain sorghum. Because of the shape of many areas of this soil and because this soil commonly occurs with soils of slightly finer texture, field irrigations often cannot be regulated to provide sufficient moisture at all times for crops on this soil. Fertilizer requirements are similar to those for Hesperia fine sandy loam, moderately deep. Newly reclaimed areas of this soil may be free of pests and soilborne diseases for a while. This advantage can be prolonged if care is taken to avoid contamination. Capability unit IIs-6 (17, 18); range site not assigned; natural land type A1-2s; Storie index rating 71.

Hesperia sandy loam, moderately deep (0 to 2 percent slopes) (Hsm).—The profile of this soil is similar to that of Hesperia fine sandy loam, moderately deep, but it is sandy loam above the silty layer. The available water holding capacity of the profile above the silty material is moderate.

Hesperia sandy loam, moderately deep, is on the central parts of the young fans of Kings River and San Joaquin River. Some small areas of gently sloping coarse sandy loams were included with this soil in mapping. These included areas occupy small, inconspicuous knolls or the gentle side slopes of wind-scoured hollows. Also included in such depressional sites were similar soils that contain prominent mottles in the underlying material. Under natural conditions those soils were subject to seasonal flooding and a fluctuating high water table.

Except for the need of somewhat more frequent

irrigations, the use and management of Hesperia sandy loam, moderately deep, are similar to those of Hesperia fine sandy loam, moderately deep. Capability unit IIs–3 (17); range site not assigned; natural land type A2; Storie index rating 90.

Hesperia sandy loam, moderately deep, saline-alkali (0 to 2 percent slopes) (Hsn).—The profile of this soil is similar to that of Hesperia fine sandy loam, moderately deep, but is sandy loam and is saline-alkali affected. The underlying material is strongly alkaline and normally is slightly saline from accumulations of neutral and basic salts. From 5 to 33 percent of the surface is saline-alkali affected in most areas of this soil. The available water holding capacity is moderate when this soil is reclaimed.

The soil is in areas of varying shapes and sizes on the lower parts of the young fans of both rivers. Some areas extend into the basin rim zone.

The use and management of this soil are similar to those for Hesperia fine sandy loam, moderately deep, saline-alkali. The somewhat coarser texture requires somewhat more frequent irrigations to maintain an optimum content of moisture in the rooting zone. Capability unit IIIs–6 (17); range site not assigned; natural land type A2–2s; Storie index rating 50.

Hesperia sandy loam, shallow (0 to 2 percent slopes) (Hso).—The profile of this soil is similar to that of Hesperia fine sandy loam, moderately deep, but it has a surface layer of sandy loam and is underlain by a compact, silty layer at a depth that ranges from 12 to 24 inches but averages 18 inches. Truncation of the surface layer through land leveling or smoothing has contributed to the shallowness of this soil. The available water holding capacity is low.

The soil is in the vicinity of Kerman. Small areas of this soil have a silty layer at a depth of 2¼ to 3 feet. There are several areas of similar soil, previously saline-alkali affected, that have been effectively reclaimed.

Alfalfa, cotton, and irrigated pasture are grown on this soil. The moisture content in the rooting zone must be watched closely to avoid a lack of sufficient moisture for crops. This is particularly important for cotton. More frequent irrigations are needed for this soil than for Hesperia fine sandy loam, moderately deep. Deep chiselling or ripping increases the effective depth of this soil somewhat. Fertilizer needs of the soil are similar to those of Hesperia fine sandy loam, moderately deep. Capability unit IIIs–3 (17); range site not assigned; natural land type A2. Storie index rating 77.

Hesperia sandy loam, shallow, saline-alkali (0 to 2 percent slopes) (Hsp).—The profile of this soil is similar to that of Hesperia fine sandy loam, moderately deep, but the surface layer is sandy loam, and the layer just below it is thinner and rests on a compact silty layer at a depth mainly of 1½ to 2 feet but ranging from 1 to 3 feet. In addition, the underlying material is strongly alkaline and normally at least slightly saline from both neutral and basic salts. Under natural conditions, three-fourths of the acreage of this soil has from 5 percent to more than 66 percent of the surface layer similarly affected. The available water holding capacity in reclaimed areas is low.

The soil is mainly west and southwest of Kerman, within the basin rim zone of the young fan of the San Joaquin River.

Most of this soil is uncultivated and used for alkali pasture. However, it will soon be leveled and reclaimed for field crops such as cotton, alfalfa, irrigated pasture, grain sorghum, and sugar beets. Reclamation is feasible, but careful attention is needed to effect initial reclamation and to keep the soil reclaimed. Capability unit IIIs–6 (17); range site not assigned; natural land type A2–2m; Storie index rating 31.

Hideaway Series

The Hideaway series consists of well-drained, extremely stony, very shallow medium textured soils that formed in material weathered from basalt rock. The soils are undulating to rolling on several old tablelands in the foothills east of Millerton Lake. The basalt parent rock has a very coarse columnar structure, and the tablelands are erosional remnants of Miocene lava flows that once filled an ancestral canyon of the San Joaquin River.

The soils are at elevations of 1,500 to 2,400 feet. The average annual precipitation ranges from 17 to 22 inches, the average annual temperature from 60° to 57° F., and the average frost-free season from 200 to 225 days. The natural vegetation is mainly a poor growth of annual grasses, forbs, and mosses. In many places uncommon plants grow around the scattered vernal pools that develop late in the rainy season. A few interior live oaks grow along the rim of the tablelands or mesas.

Typically, the Hideaway soils have a dark-brown, medium acid to strongly acid very stony loam surface layer about 3 inches thick. This layer is directly over slightly weathered basalt.

These soils are very stony or cobbly. The basaltic cobblestones and stones that litter the surface measure from 6 to 24 inches in rough diameter. Old flow patterns of the parent rock are reflected on the surface in a series of narrow, somewhat arcuate, low ridges of basaltic rubble that cut across the mesas at about right angles to the old line of flow.

Representative profile in undulating area of extremely stony rangeland supporting a sparse stand of annual grasses and forbs, on a west-facing slope of 5 percent, at an elevation of about 2,230 feet (on the western part of Squaw Leap, a basalt-capped mesa, about 3 miles W. of Auberry in the SW¼SW¼ of sec. 11, T. 10 S., R. 22 E.):

A1—0 to 3 inches, dark-brown (10YR 4/3) extremely stony loam, very dark grayish brown (10YR 3/2) when moist; massive, breaking to granular fragments, hard when dry, friable when moist, slightly sticky and nonplastic when wet; very few fine roots; few fine tubular pores, many, angular, fine gravel fragments of basalt; chiefly medium acid (pH 6.0) but strongly acid (pH [illegible]) just above the R horizon; very abrupt irregular lower boundary.

R—3 inches +, dark-brown basalt, somewhat broken by vertical cracks; very slightly weathered at upper contact with soil; many feet thick.

Depth of soil ranges from 2 to 10 inches and is commonly less than 6 inches. The color of the A horizon is commonly brown or dark brown (10YR 5/3 or 4/3) but ranges to strong brown or light yellowish brown (7.5YR 5/6, 10YR 6/4). When moist, the soil is very dark grayish brown or very dark brown (10YR 3/2 or 3/3). The texture is typically loam but ranges to fine sandy loam. The coarse fragments make the soil extremely cobbly or extremely stony. In places there is a thin granular surface layer seldom more than 1 inch thick. The reaction normally ranges from medium to strongly acid, but in places the surface is slightly acid.

Hideaway extremely stony loam, 2 to 15 percent slopes (HtC).—This soil has the profile and range of characteristics described as typical for the series. The rubbly ridges that reflect the old flow patterns of the basalt are included in this unit, as are small, crescentic, stone-free areas that are somewhat depressed and contain deeper soils. This soil is on mesas such as Table Mountain, near Millerton Lake, to Squaw Leap west of Auberry.

The soil is well drained and moderately permeable. The underlying rock transmits internally draining water only along vertical joint planes. Runoff is medium, and the hazard of erosion is slight. Fertility is low, and the available water holding capacity is very low.

This soil has been used solely for spring range or as holding pastures for limited periods because of its unique position. Along the edges of the mesas, there are cliffs of fluted, columnar basalt that drop away sheerly for 100 feet or more. Once livestock are on the mesas, only a limited amount of fencing is needed to confine them. The forage, however, is poor. Water is limited to local runoff. Ephemeral pools collect in some low spots during the rainy season, and small dams have been constructed to collect and store a larger amount of the surface runoff for use by livestock. The limited water-holding capacity and stoniness make fertilization of this soil impractical. Capability unit VIIs-7 (17, 18); range site 10; natural land type E8; Storie index rating 5.

Hildreth Series

The Hildreth series consists of deep, somewhat poorly drained, dark-colored, fine-textured soils. These soils formed in swales and in sluggish, intermittent drainageways incised in the lower foothills and in adjoining dissected terrace lands. The parent material consists mainly of fine-textured material transported from granitic soil areas by slowly moving water or through soil creep.

These soils are at elevations of 500 to 1,000 feet. According to elevation, average annual rainfall ranges from 14 to 17 inches. The average annual temperature is about 62° F., and the average growing season ranges from 250 to 275 days. The natural vegetation consists of annual grasses and forbs, mainly burclover and filaree.

In a typical profile, the surface layer is dark-gray, neutral clay about 10 inches thick. This layer overlies somewhat mottled layers of a similar material that are moderately alkaline and weakly calcareous in the lower part. When the soil is dry, cracks as much as 1 inch wide form and may extend downward several feet. The clay is underlain by unrelated soil material at a depth of about 46 inches.

The Hildreth soils are used mainly for grazing because they are near areas of other soils used for range.

Representative profile in a broad, very gently sloping swale in native pasture having a good cover of annual grasses and forbs, including clovers, at an elevation of about 535 feet (about 4 miles, airline N. of Centerville near center of sec. 16 T. 13 S., R. 23 E.):

A1—0 to 10 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; common, fine to medium, distinct mottles that are brown to dark grayish brown when dry and dark brown to very dark grayish brown when moist; strong, very coarse to medium, angular blocky structure, adobe surface cracking, blocks measure 7 to 12 inches across, and cracks are 1/2 inch to 1 inch wide, and 6 to 12 inches deep, very hard when dry, firm when moist, very sticky and plastic when wet, plentiful fine roots; few fine tubular pores; weak slickenslides sloping 45 to 60 degrees; scattering of coarse sand and fine gravel-sized particles of quartz and feldspar; neutral (pH 7.0); clear, wavy lower boundary.

C1—10 to 26 inches, dark-gray (10YR 4/1) clay, similar color when moist; mottling similar to that of A horizon; massive in place but readily breaks into angular blocks; very hard when dry, firm when moist, very sticky and plastic when wet; plentiful very fine roots; few fine tubular pores; some slickenside faces sloping 45 to 60 degrees; scattering of clean, coarse sand and fine gravel-sized particles of quartz and feldspar; mildly alkaline (pH 7.5); clear, irregular lower boundary.

C2—26 to 46 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) when moist, few, fine to moderate, distinct mottles similar in color to those in A1 and C1 horizons; massive in place, breaking readily to angular blocks; very hard when dry, firm when moist, very sticky and plastic when wet; few very fine roots; very few, very fine tubular pores, very few slickenside faces; scattering of clean coarse sand and fine gravel-sized particles of quartz and feldspar, slightly calcareous, with lime segregated in fine, rounded nodules; moderately alkaline (pH 8.0), clear, irregular lower boundary.

IIC3—46 to 64 inches, brown (10YR 5/3) coarse sandy loam, dark brown (10YR 4/3) when moist, massive; slightly hard when dry, very friable when moist, many fine interstitial pores, occasional rounded, mixed pebbles mildly alkaline (pH 7.5); abrupt, wavy lower boundary.

IIIC4—64 inches +, partly decomposed quartz diorite that is variably colored yellowish brown and very pale brown and contains scattered dark minerals, grades to unweathered rock.

The A horizon is typically dark in color; it ranges from dark grayish brown to dark gray. The hue is generally 10YR, although in places it is 2.5Y. The value is 4 and chroma is 1 or 2. When the A horizon is moist, its color may be very dark grayish brown, dark gray, or black. The hue does not change; the value drops to 2 or 3, and the chroma may be 0 or 1. The distinct mottling described in the representative profile is not present in some places. The structure is generally angular blocky, but the peds vary in size from fine to very coarse. The reaction ranges from neutral to slightly acid.

The color of the C horizon is similar to that of the A horizon, but with depth it tends to increase slightly in value, chroma, or both. Distinct mottling is typical. The structure and consistence show little variation from that described as representative. The upper part of the C horizon may be neutral to moderately alkaline, but the lower part is moderately alkaline and calcareous. The lime generally appears in

fine nodular form, but slight amounts are disseminated in places.

The underlying, lithologically discontinuous material is commonly weathered granitic rock, but in some places it is coarse alluvium or consolidated sandy sediments, locally called pack sand.

Hildreth clay (0 to 2 percent slopes) (Hu).—This is the only Hildreth soil mapped in the area. It is widely distributed along the edge of the foothills from Friant to Orange Cove. It is mainly nearly level and smooth, but there are a few small hummocks in places.

This soil is somewhat poorly drained during the rainy season because it occurs in sluggishly drained swales. The permeability of the soil is very slow. Runoff is slow after the soil has become wet and the cracks have swelled shut. The available water holding capacity is high, and there is no hazard of erosion.

Included with this soil in mapping were small areas of soils that have a surface layer of clay loam or cobbly clay. Also included were small areas of a similar soil that has slopes of 3 to 9 percent.

Hildreth clay is used mainly for grazing. Because of its high water-holding capacity and commonly associated seeps, this soil generally provides green feed longer than adjacent soils of the uplands. Some areas of this soil are in fields used for dryfarmed barley. Yields are often poor in years of normal rainfall because of excess moisture, which retards plant growth until late in the growing season. Capability unit IIIw-5 (17, 18); range site not assigned; natural land type A4–1f; Storie index rating 36.

Holland Series

The Holland series consists of deep to very deep, well-drained soils with thick fine textured subsoils formed in place, under forest from the weathering of granitic rock, principally quartz diorite and granodiorite. These soils are inextensive in this survey area; they are in the lower lying parts of more extensive areas of Holland soil that exist in the Sequoia National Forest east of the survey area.

These soils are on protected canyon slopes and spur ridges in the upper foothills at elevations ranging from 3,500 to 4,500 feet. The average annual precipitation ranges from 30 to 35 inches, the average annual temperature is about 53° F., and the average frost-free season ranges from 125 to 150 days. The natural vegetation consists of a semiopen to semidense cover of conifers, together with scattered hardwoods and a dense to open understory cover of shrubs. Annual grasses and forbs grow in open places. The conifers are ponderosa pine and some incense-cedar; the hardwoods are black oak and canyon live oak; the shrubs consist mainly of mariposa manzanita, deer brush, wedgeleaf ceanothus, poison-oak, and bear-clover.

A typical profile in this survey area has a brown slightly acid coarse sandy loam surface layer that is high in content of organic matter and is about 10 inches thick. The boundary between the surface layer and subsoil is not abrupt. The subsoil is a thick, reddish-brown, moderately acid sandy clay loam. It grades into well-weathered granitic rock at a depth of about 75 inches.

Representative profile on a moderately steep, southeast-facing slope under a cover of dense shrubs and some ponderosa pine, at an elevation of about 3,800 feet (about 0.1 mile N. of the junction of Dunlap Road and State Highway 69, on the W. side of Highway 69; SW. of Pinehurst in the NE¼ sec. 27, T. 14 S., R 27 E.):

O1—A very thin litter of dried, partly decomposed shrub leaves and pine needles.

A11—0 to 2 inches, brown (10YR 5/3) coarse sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate medium granular structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; few fine roots; slightly acid (pH 6.2); abrupt, wavy lower boundary.

A12—2 to 10 inches, brown (10YR 5/3) coarse sandy loam, dark brown (10YR 3/3) when moist; weak, medium granular structure; hard when dry, friable when moist, nonsticky and nonplastic when wet; few to plentiful coarse roots variably distributed; common fine tubular pores; slightly acid (ph 6.3); clear, wavy lower boundary.

B21t—10 to 25 inches, reddish-brown (5YR 5/4) sandy clay loam, dark reddish brown (2.5YR 3/4) when moist; moderate, coarse to very coarse, blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; plentiful fine roots; common fine tubular pores; many moderately thick, brown (7.5YR 5/4) clay films on ped faces, dark reddish brown (5YR 3/4) when moist; medium acid (pH 6.0); gradual, wavy lower boundary.

B22t—25 to 45 inches, reddish brown (5YR 4/4) sandy clay loam, dark reddish brown near dark red (2.5YR 3/4, 3/6) when moist; moderate, coarse to very coarse blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; common fine roots; few fine tubular pores; many, moderately thick, reddish brown (5YR 4/3) clay films on ped faces, reddish brown (2.5YR 4/4) when moist; medium acid (pH 6.0); gradual, wavy lower boundary.

B3—45 to 75 inches, reddish-brown (5YR to 7.5YR 5/4) light sandy clay loam, reddish brown (5YR 4/3) when moist; weak, coarse, subangular blocky structure to massive; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many very fine and microscopic interstitial pores; few thin clay films on ped faces or in pores; medium acid (pH 6.0); clear, wavy lower boundary.

C—75 inches +, very pale brown (10YR 8/4, 7/3) with dark-gray flecks, weathered quartz diorite, reddish yellow (7.5YR 6/6) with dark gray flecks when moist; granitic rock fabric still visible; hard when dry, friable when moist; many very fine and microscopic interstitial pores; many feet to unweathered parent rock.

The dry color of the A horizon ranges only from brown to grayish brown (10YR 5/3, 5/2). Moist colors are very dark brown, dark brown, and very dark grayish brown (10YR 2/2, 3/3, and 3/2). The reaction ranges from slightly acid to medium acid. The structure is typically medium granular but varies in grade from place to place. The texture is coarse sandy loam or sandy loam, and in places the A horizon has a loamy appearance and feel because of the large amount of organic matter present. The thickness of the A horizon ranges from 8 to 14 inches but is commonly at least 10 inches. A transition horizon between the A and Bt horizons is present in some places and not in others. Where a transition horizon is absent, the boundary between the A and Bt horizons is clear or gradual. The A3 horizon, when present, is generally slightly richer in color, having a hue of 7.5YR. The A3 horizon is massive in places but normally has subangular blocky structure.

The Bt horizon is typically reddish brown (5YR 4/3, 4/4,

5/3, 5/4), but in places is brown (7.5YR 5/4) with reddish-brown clay films on the ped faces. In places, the color ranges to yellowish red or reddish yellow (5YR 5/6, 6/6). Moist colors are generally redder and have a lower value (2.5YR 3/4, 3/6; 5YR 3/4, 4/6). Where the dry matrix colors of peds are brown, the moist colors are reddish brown or dark brown. The texture ranges from sandy clay loam to clay loam. The subsoil structure is typically coarse to very coarse angular blocky, but it is subangular blocky in the transition layer to the C horizon. The reaction in the B horizon is generally moderately acid, but it is strongly acid in places and slightly acid in others. Thickness of the B horizon ranges from 40 to 70 inches, including the transition horizon.

The C horizon is many feet thick and consists of well-weathered quartz diorite or granodiorite. In places it appears that unweathered rock is within a few feet, but this is generally a partial exposure of a resistant boulder of disintegration within the C horizon. The original rock fabric is clearly visible throughout the C horizon.

Holland coarse sandy loam, 15 to 45 percent slopes (HvE).—This is the only Holland soil mapped in the survey area. It is not extensive and is located near Pinehurst on parts of Milk Ranch Creek canyon, and on parts of the watershed of Badger Creek. The permeability is moderately slow. Runoff is medium to rapid, and the hazard of erosion is moderate to high. The available water holding capacity is high.

Included with this soil east of Stony Flat is a small area of similar soils that were derived from schist and have a loam surface layer and a heavy clay loam subsoil. In places, there are occasional spiny outcrops of vein rock and of parent schist rock associated with the inclusion. Elsewhere, there are few or no parent rock outcrops.

The limited acreage of this soil within the survey area is used mainly for some grazing but also for country residential or recreational homesites. Water is obtained locally from springs and creeks. The natural vegetation provides some cover and food sources for wildlife. There is little or no management of the limited cover of coniferous trees and no attempts to harvest the trees. Capability unit VIe-1 (22); range site 2; natural land type E11; Storie index rating 26.

Honcut Series

The Honcut series consists of well-drained soils that formed in recent, moderately coarse textured alluvium from basic igneous and metamorphosed basic igneous rocks. The soils are extensively distributed in small areas along the eastern edge of the San Joaquin Valley and in some valleys in the lower foothills. These nearly level to gently sloping soils occupy smooth alluvial fans or narrow flood plains of small streams.

The largest areas of these soils are near Owens Mountain, north of the Kings River, and in the vicinity of Tivy Mountain, south of the River. They are at elevations of 400 to 600 feet in the Valley and up to about 1,500 feet in some foothill valleys. The average annual precipitation ranges from 14 to 20 inches, according to elevation, the average annual temperature from 62° to 60° F., and the average growing season from 250 to 275 days. The natural vegetation consists of annual grasses and forbs. There is some valley oak in the foothill valleys.

In a typical profile, the surface layer is a brown, slightly acid fine sandy loam about 12 inches thick. The surface layer overlies a thick layer of brown fine sandy loam and gravelly fine sandy loam that is slightly acid or neutral. At a depth of about 52 inches there is a thick layer of gravel.

Most areas of these soils lie in places that are best used as rangeland. Therefore, the soils are used mainly for grazing and are highly suitable for use as dry pasture. A few small areas have been used to grow dryfarmed grain for hay. Intermittent streams and shallow low volume producing wells are the local sources of water.

Representative profile in a native pasture supporting annual grasses and forbs on a very gentle south facing slope of a recent fan, at an elevation of about 450 feet ($1\frac{1}{4}$ miles E. of the Copper Mine Substation and about $\frac{1}{4}$ mile S. of a part of the Friant-Kern Canal in the NE¼NE¼ of sec. 14, T. 12 S., R. 21 E.):

A11—0 to 4 inches, brown (7.5YR 4/3) fine sandy loam, dark brown (7.5YR 3/2) when moist; massive breaking to weak, coarse, platy structure; hard when dry, friable when moist, nonsticky and nonplastic when wet; slightly compacted by trampling of grazing animals; abundant fine and very fine roots; common fine and very fine tubular pores; slightly acid (pH 6.5); abrupt, wavy lower boundary.

A12—4 to 12 inches, similar in color and texture to A11 horizon, massive, hard when dry, very friable when moist, nonsticky and nonplastic when wet; abundant fine and very fine roots, many fine and very fine tubular pores, many very fine and microsize interstitial pores; slightly acid (pH 6.5); gradual, wavy lower boundary.

C1—12 to 30 inches, brown (7.5YR 4/3) fine sandy loam, dark brown (7.5YR 3/3) when moist, massive; hard when dry, very friable when moist, nonsticky and nonplastic when wet, plentiful fine and very fine roots; common fine and very fine tubular pores, many very fine and microsize interstitial pores; few angular gravels of hornblende schist, slightly acid (pH 6.5); gradual, wavy lower boundary.

C2—30 to 52 inches, brown (7.5YR 4/4) gravelly fine sandy loam, dark brown (7.5YR 3/4) when moist, massive, hard when dry, very friable when moist, nonsticky and nonplastic when wet; few fine roots; few fine and very fine tubular pores, many very fine and microsize interstitial pores; few, thin nongravelly layers of fine sandy loam; neutral (pH 6.7); abrupt, irregular lower boundary.

IIC3—52 inches +, dark gray to reddish-brown, slightly weathered gravel from metamorphic basic volcanic rock and associated aplite veins; loose; some fine sandy loam material intermixed.

The A horizon ranges from brown to dark brown, tending in places to grade toward reddish brown. The hue is 10YR or 7.5YR. When dry, the value is generally 4 but in some places it is 5 where the hue is 7.5YR. Chroma is normally 2 or 3. When moist, the tendency to grade toward a reddish or dark reddish brown is increased. Value is generally about 1 unit lower, and chroma remains close to 2. The C horizon is similar in color, but it is about one unit of chroma brighter when moist or dry.

Texture of both A and C horizons ranges from sandy loam to loam. In places the C horizon is stratified with gravelly and nongravelly material. The IIC horizon is not present in all places. The surface compaction from trampling varies from area to area and in places it is absent. The A horizon is neutral to slightly acid in reaction. The C

horizon is commonly neutral but in places is mildly alkaline to slightly acid.

The profile is normally deep. In places it overlies gravel layers or an unrelated, compact, sandy substratum at a depth from about 24 to 40 inches.

Honcut fine sandy loam, 0 to 3 percent slopes (HwA).—The profile of this soil commonly is similar to that described as typical for the series. In some places there is a gravel layer at a depth of 50 inches, and in other places there is none. The texture of the underlying material below a depth of 30 inches is gravelly fine sandy loam, fine sandy loam, sandy loam, or gravelly sandy loam, or stratified combinations of these textures.

Runoff is slow, and the permeability is moderately rapid. The available water holding capacity is moderate. The hazard of erosion is slight or negligible.

This soil is in many small areas that are widely distributed. Some are near Owens Mountain, others are in Watts Valley, and still others are along Holland and Hughes Creeks. South of the Kings River, the soil is in Tivy Valley and Clark Valley; in the eastern part of Squaw Valley; and along tributaries to Mill Creek and Sand Creek.

Included with this soil in mapping were small areas of a similar soil having a loam surface layer. The included soil is located near Owens Mountain, west of Round Mountain, and in Tivy Valley.

Honcut fine sandy loam, 0 to 3 percent slopes, is used mainly for grazing. Most areas of this soil, which are generally near nonarable soils, are generally too small to be used efficiently for crops. Also, there is no dependable source of irrigation water for most areas. An exception is in Tivy Valley where a part of the acreage is irrigated and used for grapes and alfalfa. A few areas in the foothill valleys are dryfarmed for hay. Where the soil is used for grazing, forage plants respond to nitrogen fertilizers. Capability unit IIs–4 (17); range site not assigned; natural land type A1; Storie index rating 100.

Honcut fine sandy loam, 3 to 9 percent slopes (HwB).—The profile of this soil is similar to that of Honcut fine sandy loam, 0 to 3 percent slopes. It is in several foothill valleys on gently to moderately sloping alluvial fans. Runoff is slow to medium. The hazard of erosion is slight.

Included with this soil were a few small areas of a similar soil having a sandy loam surface layer.

Honcut fine sandy loam, 3 to 9 percent slopes, is used principally for grazing. Many areas of it are suited to dry pasture. A few areas have been used for dryfarmed grain cut for hay. There are no reliable sources of irrigation water for this soil. Capability unit IIe–1 (17, 18); range site not assigned; natural land type A1; Storie index rating 90.

Honcut fine sandy loam, gravelly substratum, 0 to 3 percent slopes (HyA).—This soil is similar to Honcut fine sandy loam, 0 to 3 percent slopes, but differs in overlying a thick, loose layer of angular gravels of mixed basic igneous and metamorphic rocks. The depth of soil to the gravelly layer ranges from 2 to 3 feet. Texture of the surface layer ranges from fine sandy loam to sandy loam. Some areas of this soil in gentle drainage swales are grayish brown. The available water-holding capacity is low. Deep rooting is limited by the gravelly layer, and there is a slowing of internal drainage at the gravelly contact.

The soil is on small stream flood plains or fans in many foothill valleys. A large proportion is in Wunder Valley.

Included with this soil were a few small areas of moderately sloping soils that have a gravelly substratum at a depth of less than 20 inches.

This soil is used for grazing and some dryfarmed grain for hay. Growth is poor unless the rainfall is normal or better and evenly distributed throughout the growing season. Capability unit IIIs-4 (17); range site not assigned; natural land type A1–lf; Storie index rating 77.

Honcut fine sandy loam, hard substratum, 0 to 3 percent slopes (HzA).—The profile of this soil is similar to that of Honcut fine sandy loam, 0 to 3 percent slopes, but it overlies an unrelated, compact, weakly cemented sandy layer at a depth ranging from 30 to 40 inches. This layer restricts internal drainage and deep root growth. Although the soil is seasonally saturated above the hard layer, drainage is sufficient to avoid the development of poorly drained characteristics. The available water holding capacity is low.

Most of the acreage is located at the mouth of Holland Creek Valley, northeast of Centerville. A few acres lie in foothill valleys.

Areas of this soil in foothill valleys are used for grazing or dry pasture. Irrigation water is available in the lower parts of Holland Creek Valley, which also is located in a zone of relatively low frost hazard. The soil can be modified by ripping the hard layer to increase the effective soil depth in preparation for cropping. Continued care in irrigation is required to minimize the development of a saturated zone above the partly broken hard layer. Capability unit IIIs–3 (17); range site not assigned; natural land type A9; Storie index rating 65.

Keefers Series

The Keefers series consists of well-drained, reddish soils with a fine textured slowly permeable subsoil. These soils are moderately deep to very cobbly colluvium. They formed in colluvial accumulations of basic igneous rock materials on the foot slopes of hills and ridges in the foothills. In many places the surface is studded with cobblestones and stones, but it is generally smooth and gently sloping to moderately steep. Streams draining areas of these soils have cut deeply into them.

The soils are at elevations of 1,000 to 2,000 feet. According to elevation, the average annual precipitation ranges from 18 to 25 inches, average annual temperature ranges from 61° to 58° F., and the frost-free growing season ranges from 175 to 200 days. The natural vegetation consists mainly of annual grasses and forbs, but there are scattered blue oaks and interior live oaks.

Typically the Keefers soils in this survey area have a brown, slightly acid cobbly loam surface layer about 6 inches thick. The subsoil is dark-red and red, neutral

cobbly clay that grades irregularly into cobbly parent material at a depth of about 32 inches.

Representative profile in an area of range that supports annual grasses and forbs and scattered, young blue oaks, on a south-southwesterly slope of 12 percent, at an elevation of about 1,525 feet (on the W. side of Hills Valley Road, 150 yards S. of the junction of State Highway 180 and Hills Valley Road; in the SW¼NW¼NW¼ sec. 8, T. 14 S., R. 25 E.):

A1—0 to 6 inches, brown (10YR 4/3) cobbly loam, dark brown (7.5YR 3/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant fine roots, few fine pores; approximately 20 percent angular cobblestones in horizon and about 10 percent on surface; slightly acid (pH 6.5); abrupt, wavy lower boundary.

B21t—6 to 21 inches, dark-red (2.5YR 3/6) cobbly clay, dark reddish brown (2.5YR 3/4) when moist; moderate, fine, subangular blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; abundant fine roots; common fine tubular pores, many thin clay films on ped faces and in pores; approximately 30 percent angular cobblestones in horizon; neutral (pH 7.0); gradual, wavy lower boundary.

B22t—21 to 32 inches, red (2.5YR 4/6) cobbly clay, dark red (2.5YR 3/6) when moist; moderate, fine, subangular blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; few fine roots; few fine tubular pores; many moderately thick clay films on faces; continuous moderately thick clay films on pore walls; approximately 50 percent angular cobblestones in horizon; neutral (pH 7.0); abrupt, irregular lower boundary.

C—32 inches +, very cobbly colluvium from basic igneous rocks, many pebbles and stones; interstices between coarse fragments filled with reddish-brown loamy or gritty clay loam material; several feet thick; lies abruptly and unevenly on weathered rock.

The color of the A horizon ranges from brown to dark brown (10YR 4/3, 5/3, 7.5YR 4/4, 5/4). When moist, color ranges from dark brown (7.5YR 3/2, 4/2) to reddish brown (5YR 4/3) or dark reddish brown (5YR 3/3). The thickness of the A horizon ranges from about 5 to 10 inches. Cobblestones are present in some places. The A horizon is massive in places, particularly where it has been heavily trampled by grazing animals. In other places it has fine or medium granular structure. Dry consistence ranges from slightly hard to hard. The reaction ranges from slightly acid to medium acid.

The Bt horizon ranges in color from reddish brown or dark reddish brown (2.5YR 3/4, 4/4) to red or dark red (2.5YR 3/6, 4/6). Moist colors are generally similar in hue, value, and chroma, but in places are 1 unit lower in value or 1 or 2 units duller in chroma. The texture ordinarily is cobbly clay but is gravelly clay or cobbly sandy clay in places. Structure is generally moderate, fine to medium, subangular or angular blocky. Dry consistence is hard or very hard. Reaction ranges from slightly acid to neutral. The solum ranges from about 22 to 36 inches in thickness. The underlying C horizon of very gravelly or very cobbly colluvial material has a great variation of thickness. It occurs on weathered or unweathered country rock at a depth ranging from 3 to 20 feet.

Keefers cobbly loam, 3 to 30 percent slopes (KfD).—The profile of this soil is similar to the one described as typical for the series. The surface layer is consistently cobbly loam having stones, 1 to 2 feet in diameter, scattered on the surface.

Runoff is medium, but because of the slow subsoil permeability, the surface layer remains saturated for appreciable periods during the rainy season. At this time use of wheeled vehicles on this soil can be very difficult. The available water holding capacity is low. The hazard of erosion ranges from slight to moderate.

This soil is on colluvial footslopes and short sloping fans in the vicinity of Squaw Valley, Wonder Valley, and Humphreys Station. Most of the acreage is south of the Kings River.

Included with this soil in mapping was a small area of a similar soil near White Deer Flat at an elevation of about 3,000 feet. This inclusion supports a dense shrub and oak cover which contributes to a higher organic-matter content. Also included were small areas, generally drier, where the color of the moist surface layer has a brighter chroma, which reflects a somewhat lower content of organic matter.

The cobblestones and stones in the surface layer discourage cultivation of this soil. The soil is used for grazing. Some areas that are less steep and accessible can be fertilized and used for dry pasture. The forage responds to nitrogen and phosphorus if moisture is adequate during the growing season. Capability unit VIe-R (18); range site 8; natural land type C12; Storie index rating 18.

Keefers loam, 3 to 15 percent slopes (KeC).—The profile of this soil is similar to that of Keefers cobbly loam, 3 to 30 percent slopes, but it has an essentially cobble-free surface layer of sufficient thickness for light cultivation. Some areas were included from place to place where there are stones and cobblestones scattered on the surface.

This soil is on colluvial fans along the sides of Wonder Valley and near the head of Tretten Canyon. In the Tretten Canyon area, fans have been incised in places by natural drains, causing a broadly corrugated relief.

The soil is used for pasture or dryfarmed grain-hay. If water were available, some areas of the soil would be suited to pasture irrigated by sprinklers. Capability unit IIIe-8 (18); range site 8; natural land type C9; Storie index rating 32.

Keyes Series

The soils of the Keyes series are undulating to rolling, are well drained, and are underlain by a shallow, well-cemented hardpan. They formed from old gravelly or cobbly alluvium from mixed sources, principally basic igneous rocks and metamorphic rocks.

These soils are located mainly on high alluvial terraces along the Kings River near Centerville. A minor area is located on remnants of a similar terrace near the San Joaquin River southeast of Friant. Many low hummocks dot the surface of these soils, forming a typical hog-wallow, or mima mound, microrelief.

These soils are at elevations of 450 to 600 feet. The average annual precipitation ranges from 13 to 16 inches, the average annual temperature is 62° F., and the average frost-free season is 275 days. The natural vegetation consists only of annual grasses and forbs.

Typically the Keyes soils in this survey area have a surface layer of dark grayish-brown neutral cobbly

clay loam about 2 inches thick. This layer overlies a dark-brown, neutral cobbly clay subsoil that occurs abruptly on a cobbly or gravelly hardpan at a depth of about 20 inches. The pan is the cemented upper part of a thick deposit of rounded, coarse fragments of mixed rock embedded in feldspathic sand.

For a very small acreage of these soils, surface irrigation water is available from an irrigation district canal. For the rest of the acreage, only local surface water or water from nearby intermittent streams is available. Both of these sources provide only negligible amounts. A supply of ground water is limited in the vicinity of these soils.

Representative profile in range supporting annual grasses and forbs, on a southeast facing slope of about 6 percent, at an elevation of about 500 feet. (About 2½ miles N. of Centerville on Kirkman Hill; about 1,000 feet S. and 60 feet W. of the center of sec. 29 T., 13 S., R. 23 E.):

A1—0 to 2 inches, dark grayish-brown (10YR 4/2) cobbly clay loam, dark brown (7.5YR 3/2) when moist, moderate, coarse, granular structure; hard when dry, friable when moist, slightly sticky and plastic when wet, abundant microsize roots, few microsize tubular pores; neutral (pH 7.0); abrupt, wavy lower boundary.

B1—2 to 9 inches, dark brown (10YR 4/3) cobbly light clay, dark brown (10YR 3/3) when moist, weak, coarse and medium, blocky structure; very hard when dry, firm when moist, sticky and plastic when wet, abundant microsize roots, common microsize tubular pores, many thin clay films in pores, few thin clay films on ped faces; neutral (pH 7.0), abrupt wavy lower boundary.

B21t—9 to 16 inches, dark brown (10YR 3/3) cobbly clay, similar color when moist; strong, coarse, prismatic structure breaking to moderate, medium blocky, very hard when dry, very firm when moist, sticky and plastic when wet; plentiful microsize roots, many microsize tubular pores; many thin clay films in pores and on ped faces; weak slickensiding on horizontal ped faces; neutral (pH 7.2); abrupt, wavy lower boundary.

B22t—16 to 20 inches, dark-brown (7.5YR 3/2) cobbly clay, similar color when moist; strong, coarse subangular blocky structure; very hard when dry, very firm when moist, sticky and plastic when wet, few microsize roots, few microsize tubular pores, many moderately thick clay films on cobble surfaces and adjacent ped faces, other ped surfaces appear to have pressure faces or slickensides; neutral (pH 7.3); very abrupt, wavy lower boundary.

C1m—20 to 30 inches, reddish-yellow (5YR 6/6) hardpan, yellowish red (5YR 4/6) when moist, massive, strongly cemented with silica-iron materials, occasional fractures, no continuous pores, contains 20 to 30 percent cobblestones; gradual, wavy lower boundary.

C2—30 inches +, pebbles and cobblestones 20 to 30 percent by volume, imbedded in a brown to yellowish brown, compact or weakly cemented matrix of feldspathic sands; massive; many feet thick.

The color of the A horizon ranges from dark brown to dark grayish brown (10YR 3/3, 4/3, 4/2). Moist colors are dark brown to very dark grayish brown (7.5YR 3/2, 3/4, 10YR 3/2). The color of the B horizon is dark brown (7.5YR 3/2, 10YR 3/3). Moist colors are similar but are also dark reddish brown or dark yellowish brown (5YR 3/2, 10YR 3/4) in places. The thickness of the A horizon ranges from 1 to 8 inches. The structure is less strongly developed or destroyed where trampled by livestock. The A horizon is massive or has weak to moderate granular or subangular blocky structure. The reaction is variable; it is generally slightly acid to neutral throughout the profile, but may be medium to strongly acid in places, particularly in the surface layer. In some places the B horizon is mildly alkaline. The Cm horizon ranges from about 6 to 30 inches in thickness. The material beneath is generally cobbly or gravelly but also consists of layers of compact coarse sandy loam.

Keyes cobbly clay loam, 3 to 15 percent slopes (KmC).—This is the only Keyes soil mapped in the survey area. It has the profile described as typical for the series. The depth to the hardpan ranges from about 12 to 24 inches.

Runoff is medium, but some ponding occurs in some of the intermound swales. The subsoil and hardpan are very slowly permeable. The effective root zone for plants is very shallow, and the available water holding capacity is very low. The hazard of erosion is slight to moderate.

This undulating to rolling soil occupies remnants of old alluvial terraces located mainly in the Kirkman Hill region north of Centerville.

Included with this soil in mapping were small areas of a similar soil having slopes of more than 15 percent. Also included were soils having a surface layer of loam, cobbly loam, or clay loam.

Grazing is the only use for Keyes cobbly clay loam, 3 to 15 percent slopes. The soil is used for range with other terrace and foothill soils. Capability unit IVe-3 (17); range site 8; natural land type D28; Storie index rating 13.

Los Robles Series

The Los Robles series consists of nearly level to moderately sloping, well-drained soils that have a moderately fine textured subsoil. These soils formed in young alluvium derived from basic igneous rocks. The soils are on alluvial benches and fans in the eastern part of the San Joaquin Valley, as well as in some lower foothill valleys. They formed in alluvium deposited by small streams draining the lower foothills. Some of these streams join the major drainage systems of the area. Others do not; they disappear into the valley floor.

These soils are at elevations that range from 375 to 700 feet in the eastern parts of the San Joaquin Valley and range up to about 2,000 feet in the foothills. Average annual rainfall ranges from 13 to 15 inches in the valley and up to about 25 inches in the foothills. In the valley the average annual temperature is 62° F., and in the foothills it is about 59° F. In the valley the average growing season ranges from 250 to 275 days, and in the foothills it ranges from 200 to 250 days. The natural vegetation consists mainly of annual grasses and forbs.

In a typical profile, the Los Robles soils have a brown slightly acid loam surface layer about 10 inches thick. It overlies a brown to dark-brown, neutral light clay loam subsoil, about 28 inches thick, that grades into similarly colored, neutral coarse sandy loam.

The Los Robles soils are used mainly for grazing because of their location and their nearness to other soils used for range. Some areas are used for dryfarmed

grain for hay, and others in the San Joaquin Valley are irrigated and used to grow field crops.

Representative profile in native pasture supporting annual grasses and forbs, on a very gently south sloping slope of a low, small stream terrace, at an elevation of 490 feet (in Tivy Valley; 1,200 feet ENE. of Tivy Union School in the SW¼NE¼SE¼ sec. 25, T 13 S., R 23 E.):

O1—Thin, scattered litter of dried and partly decomposed parts of grasses and forbs.

A1—0 to 10 inches, brown (10YR 5/3) loam, dark brown (7.5YR 3/2) when moist; massive, having a weak, granular appearance when moist; hard when dry, friable when moist, slightly sticky and very slightly plastic when wet; abundant fine and very fine roots; many fine and very fine tubular pores, many microscopic interstitial pores; slightly acid (pH 6.4); clear, wavy lower boundary.

B2t—10 to 38 inches, brown to dark brown (7.5YR 4/4) light clay loam, dark reddish brown (5YR 3/4) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful fine and very fine roots; common fine and very fine tubular pores, common microscopic interstitial pores, few thin clay films on ped faces; common to many, thin clay coatings on pores; neutral (pH 7.0); clear, wavy lower boundary.

IIC—38 to 60 inches, brown to dark-brown (7.5YR 4/4) coarse sandy loam, reddish brown (5YR 4/4) when moist; massive; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; few to very few fine roots; many fine to microsize interstitial pores; some clay bridging and colloidal staining of mineral grains; some fine gravel-sized fragments of feldspar and basic igneous rock; neutral (pH 6.8).

The color of the A horizon is brown or dark brown (10YR 5/3, 4/3; in some places 7.5YR 5/2, 4/3). When moist, the color is commonly dark brown but is reddish brown in places. The hue reddens to 7.5YR or, in a few places, 5YR; the value is only 3 and the chroma is 2 or 3. The B horizon is slightly richer or redder in color but still brown or dark brown. The hue is no yellower than 7.5YR, the value is 4 or 5, and the chroma is 4. When the B horizon is moist, there is little variation in color from that described. The hue reddens to 5YR, the value is 3, and the chroma is 4. The C horizon has similar color but is somewhat higher in value when moist.

Texture of the A horizon is sandy loam, loam, or clay loam. The reaction of the A horizon ranges from slightly acid to neutral; the Bt horizon ranges from neutral to mildly alkaline, as does the C horizon. In addition, slight accumulations of lime are in the C horizon in some places. The C horizon may or may not show a minor lithologic discontinuity with the solum. Where this horizon is not discontinuous, its texture is loam or sandy loam.

These soils are normally deep, but in a few places they overlie unrelated layers of gravel or a hard, sandy substratum at a depth ranging from 21 to 48 inches.

Los Robles loam, 0 to 3 percent slopes (LmA).—This soil has the profile described as typical for the series.

Runoff is slow because the soil is moderate in permeability and nearly level to very gently sloping. The available water holding capacity is high, and the hazard of erosion is generally negligible. In the foothills the hazard is slight, because overdeepening of adjacent natural drainageways is possible as a result of excessive runoff from surrounding steeper areas. Subsequent rilling or gullying of the soil may accompany the overdeepening of the natural drains unless care is given to maintaining protective vegetation on the soil.

This soil is in many small areas near intermittent streams east of Clovis and in the vicinities of Owens Mountain, Round Mountain, Campbell Mountain, and Smith Mountain. Areas of the soil are also located in Tivy Valley, Clark Valley, and Citrus Cove. At higher elevations in the foothills, the soil is in Watts Valley and Burrough Valley.

Included with this soil in mapping was a minor area of a similar soil having a fine sandy loam surface layer. Also included, in some foothill valleys, were very small areas of a similar soil having a darker surface layer than typical and other small areas of a soil having a finer textured subsoil than normal.

Los Robles loam, 0 to 3 percent slopes, is used for grazing because the areas are small and are in parts of the terrace lands and foothills that are used for this purpose. Many areas of the soil are suitable for use as dry pasture. Some are used for dryfarmed grain harvested for hay. The forage on this soil responds well to nitrogen and phosphorus fertilizers. Where irrigation water is available, cotton and alfalfa are grown and are well suited. Irrigated pastures are very successful on this soil. In areas of minimum frost hazard, the soil is used to grow oranges. Capability unit I-1 (17, 18); range site not assigned; natural land type A1; Storie index rating 95.

Los Robles clay loam, 0 to 3 percent slopes (LoA).—The profile of this soil is similar to that of Los Robles loam, 0 to 3 percent slopes, but the surface layer is light clay loam that is massive and hard to very hard when dry. The subsoil is clay loam having blocky structure and very hard consistence when dry. The permeability of the soil is moderately slow. The available water holding capacity is high.

The soil is distributed in small areas near the eastern edge of the San Joaquin Valley and in some foothill valleys.

Included with this soil in mapping were small areas of similar soils that are moderately sloping. Also included were soils having a dark grayish brown surface layer, located in moderately well drained areas.

The use and management of this soil are similar to those of Los Robles loam, 0 to 3 percent slopes. Where used for grazing or for pasture, Los Robles clay loam, 0 to 3 percent slopes, provides a somewhat longer source of green feed, late in spring when the annual grass range is drying up. Cultivation of this soil is somewhat more difficult than Los Robles loam, 0 to 3 percent slopes. When dry, the clods are hard and do not break rapidly for a desirable seedbed. The soil is also easily compacted and puddled if tilled when too wet. The best results are obtained if the soil is tilled when only slightly moist. Capability unit I-1 (17, 18); range site not assigned; natural land type A1; Storie index rating 81.

Los Robles loam, 3 to 9 percent slopes (LmB).—This soil occupies young fans along the edge of the San Joaquin Valley and throughout much of the foothills in many small valleys. It has a profile that is similar to that of Los Robles loam, 0 to 3 percent slopes. Runoff is medium, and the hazard of erosion is slight to moderate.

Included with this unit in mapping were several

small areas of similar soils that have slopes of somewhat more than 9 percent; have been slightly sheet eroded and are cut by a few gullies, have a clay loam surface layer, or have a darker surface layer. One area of the inclusions having a darker surface layer has slopes of more than 9 percent and is located in Milk Ranch Canyon, near Stony Flat, at an elevation of about 4,000 feet.

Los Robles loam, 3 to 9 percent slopes, is used almost entirely for grazing in conjunction with larger areas of other soils used as range. It is suitable in many places for use as dry pasture. Where water can be made available, areas of the soil along the lower edge of the foothills would be suitable for growing early tomatoes. Capability unit IIe-1 (17, 18); range site not assigned; natural land type A1; Storie index rating 86.

Los Robles loam, hard substratum, 2 to 9 percent slopes (LnB).—The profile of this soil is similar to that of Los Robles loam, 0 to 3 percent slopes, but it has an unrelated, weakly cemented layer, several feet thick, at a depth ranging from 30 to 48 inches. This layer is similar to the thick, dense layer laying just beneath the strongly cemented platy hardpan of the Yokohl soils. The hard layer is slowly permeable, even though it is broken in places by vertical cracks. For this reason, saturated zones form temporarily in the subsoil during the rainy winter and spring months. Runoff is slow to medium; the hazard of erosion is slight to moderate. In some areas of the soil there are deeply cut gullies. The available water holding capacity is moderate, depending on the depth of the soil.

The soil is near Owens Mountain, along Fancher Creek near Round Mountain, and on the north side of Squaw Valley.

Because of the limited depth and the small acreage of this soil, areas of a similar soil that is gently or moderately sloping were included with this soil in mapping. The surface layer of the included areas ranges from sandy loam to loam.

The use of Los Robles loam, hard substratum, 2 to 9 percent slopes, is confined to dry pasture, grazing, and dryfarmed grain for hay. Forage growth responds to nitrogen and phosphorus fertilizers. Capability unit IIe-1 (17, 18); range site not assigned; natural land type A9; Storie index rating 63.

Los Robles sandy loam, 2 to 9 percent slopes (LoB).—The profile of this soil is distinguished from that of Los Robles loam, 0 to 3 percent slopes, by its sandy loam surface layer and sandy clay loam subsoil. Runoff is medium, and the hazard of erosion is slight to moderate. The available water holding capacity is moderate.

Most of the acreage is in small foothill valleys. A few small areas that are gently sloping are scattered sporadically in the eastern part of the San Joaquin Valley.

Included with this soil in mapping were small areas of similar soils having a less permeable, somewhat finer textured subsoil. Also included were other soils having a dark-colored surface layer.

The use and management of Los Robles sandy loam, 2 to 9 percent slopes, are similar to those of Los Robles loam, 0 to 3 percent slopes. However, a much smaller acreage of this soil has water available for irrigation or is favorably located for cultivation. Most of it is used for grazing or dry pasture. Some is used for dryfarmed grain grown for hay. Capability unit IIe-1 (17, 18); range site not assigned; natural land type A1; Storie index rating 81.

Los Robles sandy loam, gravelly substratum, 2 to 9 percent slopes (LgB).—This soil has a profile that is similar to that of Los Robles loam, 0 to 3 percent slopes, but has a sandy loam surface layer and sandy clay loam subsoil. It overlies a thick layer of angular gravel at a depth ranging from 24 to 36 inches. The gravel consists of basic igneous rocks or metamorphosed basic igneous rocks. A few pebbles or cobblestones are scattered on and in the soil. The interface between the soil and the gravel layer tends to restrict internal drainage somewhat and curtails deep rooting. The available water holding capacity is low.

Most of the acreage is located mainly in small foothill valleys such as Wonder Valley. Included with the unit are a few small areas of a similar soil having a loam surface layer.

Los Robles sandy loam, gravelly substratum, 2 to 9 percent slopes, is used for grazing or for dry pasture. It produces less forage than the deeper Los Robles sandy loam. Capability unit IIIa-4 (17); range site not assigned; natural land type A1-II; Storie index rating 69.

Madera Series

The Madera series consists of well-drained soils that have a dense fine textured subsoil and are moderately deep to a strongly cemented hardpan. The soils formed in old granitic alluvium on low terraces. They are nearly level to gently undulating, but under natural conditions they have a low hummocky microrelief. Most areas of these soils have been smoothed and are now under cultivation. In a few places these soils are saline-alkali affected.

These soils are mainly in the eastern part of the valley in the Reedley-Orange Cove district; in the vicinity of Sanger; and near Clovis, Fresno, and Kearney Park. A few minor areas are in small valleys in the lower foothills.

The soils are at elevations of 250 to 500 feet. The average annual precipitation ranges from 9 to 15 inches, the average annual temperature is about 62° F., and the average growing season ranges from 250 to 275 days.

A typical profile has a surface layer of brown, neutral and slightly acid loam about 20 inches thick. The surface layer overlies a brown subsoil that is slightly acid heavy clay loam in its upper part and moderately alkaline, calcareous clay in the lower part. It is underlain, at a depth of about 33 inches, by a thick, reddish brown, lime-iron-silica strongly cemented hardpan.

Unirrigated areas of these soils are used for grazing. Irrigated areas are used for deciduous and citrus fruits, vineyards, cotton, and alfalfa. Before these soils can be successfully used for crops, the hardpan must be ripped, broken, or blasted, and the soils leveled

Representative profile in a vineyard on a nearly level, low stream terrace, at an elevation of 395 feet. (2 miles W. of Orange Cove; 1/4 mile E., 700 feet S. of the intersection of Wakefield and Sumner Avenues, near the center of sec. 15, T. 16 S., R. 24 E.):

Ap—0 to 8 inches, brown (10YR 5/3) loam, dark grayish brown (10YR 4/2) when moist; massive; hard when dry, friable when moist, slightly sticky and nonplastic when wet; plentiful fine roots; common very fine and fine tubular pores; neutral (pH 7.0); abrupt, smooth lower boundary.

A3—8 to 20 inches, brown (10YR 5/3) loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful fine roots; common very fine and fine tubular pores; slightly acid (pH 6.5); abrupt, wavy lower boundary.

B21t—20 to 26 inches, brown (7.5YR 4/4) heavy clay loam, dark brown (7.5YR 4/2) when moist; moderate, medium, angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; few fine roots; few fine tubular pores; many moderately thick clay films on ped faces and in pores; slightly acid (pH 6.5); abrupt, wavy lower boundary.

B22t—26 to 33 inches, brown (7.5YR 4/4) clay, dark brown (7.5YR 4/2) when moist; similar to B21t horizon in structure, consistence, roots, pores, and clay film development; slightly calcareous with lime segregated in a few, rounded soft masses; moderately alkaline (pH 8.0); very abrupt, wavy lower boundary.

Cm—33 to 41 inches, reddish-brown (5YR 5/4), platy, lime-iron silica, strongly cemented hardpan; lime occurs in many fine seams; grades below depth of 41 inches into a brown, massive, compact, weakly cemented light sandy loam several feet thick.

The color of the A horizon generally is brown (10YR 5/3, 4/3). The moist color is dark grayish brown (10YR 4/2) or dark brown (10YR 4/3, 3/3). The A horizon is generally massive but breaks into clods or fine granular structure under cultivation. It is generally hard when dry but is very hard in areas subjected to excessive wheel traffic or trampling. The texture is sandy loam, loam, or clay loam. The reaction ranges mainly from slightly acid to neutral but is strongly alkaline where saline-alkali affected.

The color of the Bt horizon is normally brown (10YR 5/3; 7.5YR 4/4). When moist, the color generally is dark brown (10YR 4/3; 7.5YR 4/4, 4/2) but is dark reddish brown (5YR 3/4) in places. The texture of the Bt horizon ranges from heavy clay loam to clay or sandy clay. Structure is generally angular blocky ranging in grade from moderate to strong. Dry consistence varies from very hard to extremely hard. The reaction ranges mainly from slightly acid to neutral. In many places, however, the horizon is mildly or moderately alkaline and calcareous in the lower part. Saline-alkali affected soils are strongly alkaline in the subsoil.

The depth to the hardpan ranges from 24 to 48 inches but is commonly more than 30 inches. The color of the hardpan is brown, strong brown, yellowish brown, reddish brown, or yellowish red. The colors can occur singly or in combination.

Madera loam (0 to 2 percent slopes) (Mc).—This soil has the profile described as typical for the series. The soil formed in very slightly depressed areas on low terraces, where the general drainage was good but somewhat slower than that for other soils having a hardpan, such as the San Joaquin soils. Some of the acreage of this soil lies within the urban area of Fresno.

Runoff is slow. The water table is deep and does not affect drainage. The hazard of erosion is negligible. The available water holding capacity is low to moderate depending on the depth of the hardpan. If unbroken, the hardpan seriously impedes root growth and water penetration. Normally, a few cracks in the hardpan help somewhat in drainage.

Included with this soil in mapping was a small area of a similar soil in which the depth to hardpan is more than 48 inches but seldom greater than 60 inches. This included area lies within the city of Fresno. Also included was a small area of a similar soil having a fine sandy loam surface layer.

Nearly all the acreage of Madera loam is cultivated, except for small areas in the lower foothill valleys. After ripping or shattering the hardpan by blasting, this soil under irrigation is fairly well suited to certain tree fruit crops, vines, and field crops and cotton. It is most extensively used for vineyards, principally for table and wine grapes. Some figs and plums are grown on the soil, as well as oranges in selected areas where the frost hazard is at a minimum. It is not well suited to peaches. The soil is suited to cotton, alfalfa, irrigated pasture, corn, grain sorghum, and sugar beets. Houses and buildings occupy a small part of the soil within the city of Fresno. Only a very small acreage, located in the lower foothills near Fancher Creek, is used for grazing.

Care is required in irrigating this soil to avoid perching excess water in the rooting zone. Traffic or tillage pans that slow water penetration are easily formed. The timing of tillage operations to coincide with an optimum moisture content in the soil for cultivation, and minimizing wheeled traffic for other management operations, help to reduce the development of these mechanically packed layers. Nitrogen and phosphorus fertilizers are needed for most crops. Capability unit IIIs–3 (17); range site 8; natural land type C15; Storie index rating 88.

Madera clay loam (0 to 2 percent slopes) (Md).—The clay loam surface layer distinguishes the profile of this soil from that of Madera loam. The dry color of the surface layer tends more toward dark brown. Both texture and color indicate that the soil lies in slightly depressional areas. The available water holding capacity ranges from low to moderate. Erosion is not a hazard. The soil is in widely separated parts of the San Joaquin Valley from Kearney Park eastward.

Included with this soil in mapping were small areas of soils having a similar surface layer but having little or no subsoil development and overlying a hard, silty substratum.

Madera clay loam is used to grow cotton, irrigated pasture, plums, and oranges. The soil is selected for the particular crop grown more because of location than suitability. The soil is best suited to irrigated pasture if less intensive management is desired. Because of the size and configuration of the individual areas, the soil areas generally make up only a part of a field or management unit. It tends to dry more slowly than adjacent soils. Consequently, if it is tilled when too wet, compaction or puddling occurs. If cultivated when completely dry, the soil forms a cloddy

plow layer that is difficult to work into a good seedbed. Other management practices for the crops grown on the soil are similar to those of Madera loam. Capability unit IIIs-3 (17); range site 8; natural land type C13; Storie index rating 31.

Madera loam, saline-alkali (0 to 2 percent slopes) (Md).—This soil is saline-alkali affected, but otherwise its profile is similar to that of Madera loam. The upper few inches of the surface layer are generally mildly to moderately alkaline and weakly calcareous. In places the surface layer is strongly alkaline. The subsurface layer and subsoil are strongly alkaline, and the subsoil particularly contains a strong accumulation of carbonates. Variable amounts of neutral and basic salts are present. The color of the surface layer and subsoil in some places, particularly in the vicinity of Orange Cove, is paler than normal; it ranges from pale brown to light brownish gray. The hardpan is generally less strongly cemented and has a greater proportion of lime as a cementing agent.

The soil is in the vicinity of Kearney Park, east of Granite Hill, and north of Smith Mountain near Orange Cove. It occupies small areas near soils that are free of excess salts and alkali.

Because of its location and minor extent, this soil has been included in management units used for table grapes, wine grapes, oranges, cotton, and irrigated pasture. Reclamation has been incomplete. An obstacle to effective reclamation of this soil is the thick, massive, slowly permeable sandy layer that normally underlies the well-cemented hardpan. This layer is not easily broken and resists the development of good internal drainage for the soil. Capability unit IIIs-6 (17); range site not assigned; natural land type C13-2m; Storie index rating 20.

Madera sandy loam (0 to 2 percent slopes) (Ma).—The profile of this soil is similar to that of Madera loam, but it has a sandy loam surface layer. The depth to hardpan ranges from 2 to 3 feet, but in some places where the soil has been leveled, the depth is less than 2 feet. The thickness of the clay subsoil ranges from about 2 to 10 inches. In places the subsoil is thicker and consists entirely of heavy clay loam. In some places the upper part of the hardpan is a compact, weakly cemented sandy layer that is variably calcareous rather than a strongly cemented, platy layer. The available water holding capacity ranges from very low to moderate, depending on the depth of soil to the hardpan.

Areas of this soil are fairly well distributed in the eastern parts of the San Joaquin Valley. They are located near Reedley, Orange Cove, and Sanger; east of Fresno; northeast of Clovis; and in a small foothill valley near Academy.

Included with this soil in mapping were small areas of Ramona sandy loam and Greenfield sandy loam. Both of these soils are moderately deep over a hard layer.

The use and management of Madera sandy loam are similar to those of Madera loam. The somewhat lower moisture-holding capacity requires more frequent irrigations to maintain optimum moisture in the rooting zone. Capability unit IIIs-3 (17); range site 8; natural land type C13; Storie index rating 36.

Merced Series

The Merced series consists of clay soils that formed in moderately fine textured to fine textured alluvium derived predominantly from granitic rocks. These soils are very nearly level. They occupy a large part of the basin flood plain of the San Joaquin Valley. Most of the parent alluvium was deposited by the Kings River by way of the Fresno Slough in flood stage. Prior to development of the soils for farming, the surface was cut by many meandering distributaries of the slough as well as by tributary drains from the higher lying basin rim and young fan areas to the east. Most of these cuts have now been filled and obliterated.

These soils range in elevation from about 170 to 200 feet. The average annual precipitation is 8 inches, the average annual temperature is 63° F., and the average frost-free season ranges from 225 to 275 days from south to north.

The soils formed under very poorly drained, marshy conditions. The natural vegetation consisted of tules, bulrushes, cattails, and other water-loving plants, which contributed to the dark color and high content of organic matter normally found in the soils. Subsequent drainage of these soils through control of flooding along the river and widespread pumping of the ground water has made the soils suitable for farming. The present vegetation consists of crop plants or annual grasses and herbs. A few willow trees follow remaining sloughs or areas where sloughs were previously.

In a typical profile, the surface layer is mildly alkaline, dark-gray clay about 12 inches thick. Under this layer is olive-gray and pale-yellow, mottled clay that is mildly alkaline, and has accumulations of lime nodules or fibers below a depth of about 46 inches. The soils tend to crack widely and deeply upon drying.

Where these soils are irrigated, they are used for cotton, alfalfa seed, and small grains.

Representative profile in a field in fallow on the very nearly level flood plain of Fresno Slough, at an elevation of 180 feet (1¼ miles SE. of the town of San Joaquin; 100 feet N., 155 feet E. of the west quarter corner of the SE¼ of sec. 25, T. 15 S., R. 16 E):

Ap—0 to 4 inches, dark-gray (5Y 4/1) clay, black (5Y 2/1) when moist; strong medium to coarse blocky structure; prominent adobelike cracking when dry; very hard when dry, firm when moist, sticky and plastic when wet; few very fine roots mainly concentrated on ped or cleavage faces; few very fine tubular pores; mildly alkaline (pH 7.5); abrupt, wavy lower boundary.

A1—4 to 12 inches, dark-gray (5Y 4/1) clay, black (5Y 2/1) when moist; moderate, medium and coarse, subangular blocky structure; horizon broken by prominent vertical cracks 1 to 2 feet apart; very hard when dry, firm when moist, sticky and plastic when wet; few very fine roots, some broken by the prominent vertical cracks; mildly alkaline (pH 7.6); abrupt, wavy lower boundary.

C1—12 to 46 inches, olive-gray (5Y 5/2) clay, black (5Y 2/2) when moist; common, fine, distinct, reddish-

brown mottles; strong, coarse and very coarse, angular blocky structure, very hard and extremely hard when dry, very firm when moist, sticky and very plastic when wet; prominent vertical cracks to a depth of about 36 inches; many pressure faces and some indication of slickensides; mildly alkaline (pH 7.5); clear, irregular lower boundary.

C2ca—46 to 56 inches, light olive gray (5Y 6/2) clay, dark olive gray (5Y 3/2) when moist; common, fine, distinct, olive mottles; strong, medium and coarse, angular blocky structure; very hard when dry, very firm when moist, sticky and plastic when wet; many pressure faces; many, fine, distinct nodules of soft lime; mildly alkaline (pH 7.7); gradual, wavy lower boundary.

IIC3ca—56 to 70 inches, pale-yellow (5Y 7/3) clay loam, olive (5Y 5/3) when moist; common, fine, distinct, olive mottles; massive, hard when dry, firm to friable when moist, sticky and plastic when wet; many vertical dark streaks from old roots; common, fine, prominent nodules of soft lime; mildly alkaline (pH 7.7); clear, wavy lower boundary.

The color of the A horizon ranges from dark gray to very dark gray. The hue is 10YR, 2.5Y, or 5Y; the value is 3 or 4, and the chroma is 1 or less. When this horizon is moist, the color is black. The hue is most commonly 2.5Y or 5Y, the value is 2, and the chroma is 2 or less. In places the lower part of the A horizon is finely mottled with reddish or yellowish colors. The horizon is massive when moist, but when dry it cracks widely and deeply, and there is much secondary cracking, which causes the medium or coarse blocky structure. On thorough drying many areas become granulated on the surface. There is little or no variation in consistence. Texture ranges from clay to clay loam. The reaction ranges from neutral to moderately alkaline. In undisturbed areas the surface layer is normally noncalcareous. Lime found in the A horizon is generally the result of leveling or deep tillage.

The C horizon is variable in color but tends to become lighter colored with depth. The upper part ranges from grayish brown to olive or light brownish gray to pale olive. The hue is 2.5Y or 5Y, the value is 5 or 6, and the chroma is 2 or 3. Moist colors range from dark or very dark grayish brown to olive brown, olive, or dark olive. The hue and chroma remain the same, but the value is only 2, 3 or 4. The lower part of the C horizon has a lighter and brighter color, the brightest being associated with coarser textures. The hue remains the same, but the value is as high as 8 and the chroma as bright as 6.

The texture of the C horizon is typically clay to a depth of at least 30 or 40 inches. The structure is generally subangular blocky to angular blocky, but it is somewhat prismatic in places from the deep cracking of the soil. Slickensides are common. The lower part of the C horizon, where it is not fine textured, is massive, commonly stratified, and in places includes textures of all classes except sands. In many places, lime occurs as hard nodules or soft splotches, along with variable amounts in a disseminated form. Below a depth of 48 to 72 inches, lime accumulations diminish or disappear. In many places, clusters of gypsum crystals accompany the segregated lime. The reaction generally is mildly alkaline to moderately alkaline. In a few places it is strongly alkaline. Varying amounts of salts have accumulated in the soil material.

Merced clay, slightly saline (0 to 2 percent slopes) (Mk).—This soil is distributed in large areas along the basin flood plain from the vicinity of Burrel to the Mendota Wildlife Management Area near Whites Bridge. It has the profile described as representative for the series. The soil occupies what appears to be a flat, featureless plain, broken only by a few trees and buildings.

Considerable variation has been measured from place to place as to the amounts and location of excess salts within the soil. Commonly both the surface layer and the underlying material are slightly saline. In many places, however, the surface layer to a depth of about 12 inches is free of salts, but the underlying material is slightly saline. In some places this sequence is reversed. The salinity causes only a slight depression of crop growth. Depending upon management, some areas show little or no effects of the salts. Observations over a 10-year period have showed little or no change in levels of salt accumulation or location of such accumulation within the profile, even though the soil has been continuously cropped and irrigated.

The soil is now moderately well drained. Runoff is slow, and permeability is slow. Thus, removal of excess amounts of surface water can be troublesome. Pumping has lowered the general level of the ground water to a depth of more than 50 feet in most parts. The available water holding capacity is high. There is no erosion hazard.

Included with this soil in mapping were areas that are free of salts or contain a moderate amount in the lower part of the underlying material. Some small areas of Temple soils have also been included, as well as small areas of Piper soils. Pale-colored spots from place to place within large areas of this normally dark colored Merced soil are either leveled knolls of Piper soils or material from the deeper material underlying the Merced soil that has been exposed by leveling operations.

Merced clay, slightly saline, is used mainly for cotton. It is also used for irrigated barley, rice (fig. 5), alfalfa seed, and some grain sorghum. It is suited to field corn and sugar beets. Heavy, powerful farm machinery is needed to cultivate this soil effectively

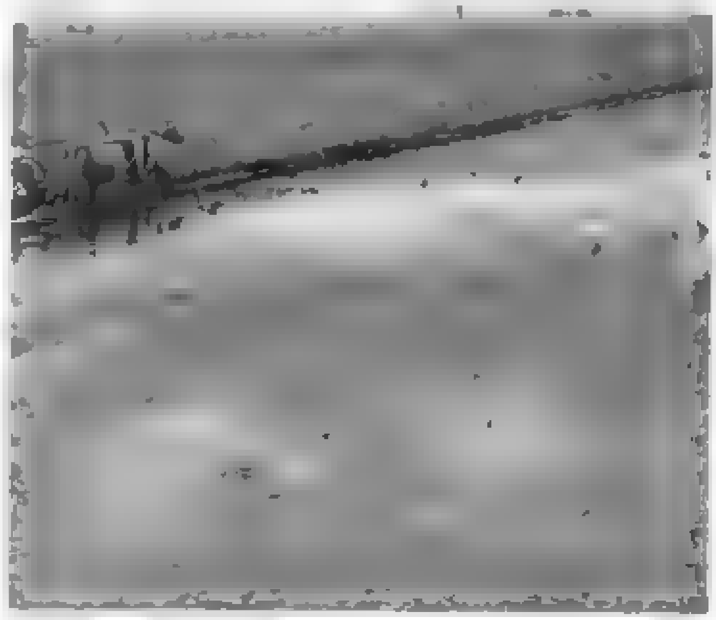

Figure 5.—Young rice plants on Merced clay, slightly saline.

and to prepare a usable seedbed. Special tools have been developed locally to improve the tilth of the soil. For best results, the soil must be cultivated when it is neither too wet nor too dry. Land leveling is commonly done each year before planting in order to improve the efficiency of irrigation.

For most crops the frequency of irrigation is less on this soil than on most other soils because of the high available water holding capacity. Runs that are one-fourth to one-half mile long are used in furrow irrigation, and the water is held in them for a long period so that deep penetration of moisture can be achieved. On this soil nitrogen and phosphorus are required for most crops. Water soluble phosphorus fertilizers have been shown to be most effective for barley. Capability unit IIs-5 (17); range site not assigned; natural land type B10-2s; Storie index rating 32.

Merced clay (0 to 2 percent slopes) (Mh).—This soil is free of harmful salt accumulations. The soil is distributed throughout the basin lands.

The use and management of this soil are similar to those of Merced clay, slightly saline. There is no reduction of crop growth because of salt accumulation. Capability unit IIs-5 (17); range site not assigned; natural land type B10; Storie index rating 35.

Merced clay, moderately saline (Ml).—The profile of this soil has a greater amount of neutral salts accumulated within it than the profile described as typical for the series. No sites measured showed a uniform distribution of salts within the profile. In many areas the surface layer is slightly saline and the underlying material is moderately saline. In places a strong accumulation of salt has formed a thin crust on the surface. In other places, the lower part of the underlying material shows strong concentrations of salt.

This soil is scattered throughout the basin area in relatively small tracts. Most of the acreage is in areas near San Joaquin, Helm, Tranquillity, and Whites Bridge. The larger areas lie along Fresno Slough.

This soil is used in conjunction with larger areas of other soils, principally other Merced soils, which are salt free or only slightly saline. The management units, or fields, are large; and the use of the soil depends mainly upon the use of the better soils nearby. The use is mainly for cotton or rice. Where the soil is furrowed and irrigated, puff spots of salts develop sporadically on the outer parts of the ridges. Crops grown in these areas show a marked reduction in growth or, in places, grow not at all. Cotton grows only fairly well. Rice does better, but not so well as on the less salty soils. Planting rice is helpful in leaching the surface layer of salt. The movement of water through this soil is so slow that it is doubtful if effective reclamation of the whole soil can be achieved within a reasonable length of time, even under rice culture. The general management of this soil is similar to that of Merced clay, slightly saline. Asymmetrically shaped ridges, which cause salts to accumulate on only one side, provide a better planting site for cotton. Capability unit IVs-6 (17); range site not assigned; natural land type B10-2m; Storie index rating 18.

Merced clay, saline-alkali (0 to 2 percent slopes) (Mm).—The profile of this soil has strongly alkaline underlying material that is at least slightly saline from an accumulation of salts and alkali. The surface layer is unaffected. The permeability of this soil is very slow.

Most of the acreage lies within the Mendota Wildlife Management Area adjacent to other saline-alkali soils of the basin rim.

This soil is seasonally flooded to provide a marshy resting site for migrating waterfowl. This is probably its best use. Except for shallow-rooted pasture grasses, no locally grown field crops produce an economic return on this soil. The very slow permeability of the soil, caused by the alkali in the clay, practically precludes reclamation. Capability unit IVs-6 (17); range site not assigned; natural land type B10-2a; Storie index rating 14.

Merced clay loam (0 to 2 percent slopes) (Mf).—This soil has a clay loam surface layer and is free of injurious accumulations of salts. Otherwise, the profile is similar to that described for the series.

The soil is distributed throughout the basin area in the vicinity of former sloughways. It also occurs in an area of very uneven width near the eastern edge of the basin flood plain.

Included with this soil in mapping were small areas of similar soils having a loam or silty clay loam surface layer.

The use and management of this soil are similar to those of Merced clay, slightly saline. The less clayey surface layer makes cultivation of this soil much easier, and better seedbed preparation is possible. Common field crops are well suited. Capability unit IIs-5 (17); range site not assigned; natural land type B9; Storie index rating 59.

Merced clay loam, slightly saline (0 to 2 percent slopes) (Mg).—The profile of this soil is similar to that described as typical for the series, except for its clay loam surface layer. The soil is distributed throughout the basin area, closely associated with areas of Merced clay loam.

Areas of similar soils having a silty clay loam surface layer are included. Also included is a small area of a similar soil having a loam surface layer, as well as small areas of a similar soil that contain moderate accumulations of salts.

The use and management of Merced clay loam, slightly saline, are similar to those of Merced clay, slightly saline. Merced clay loam, slightly saline, is more easily cultivated, however, and less preparation is required for seedbeds or for other tillage operations. Capability unit IIs-5 (17); range site not assigned; natural land type B9-2s; Storie index rating 58.

Millerton Series

The Millerton series consists of shallow, well drained to somewhat excessively drained fine sandy loam soils of the uplands that formed in place from the weathering of metamorphic basic volcanic rock, principally

hornblende schist. These soils are rolling to very steep and mountainous. Slopes are 3 to 70 percent. The soils occupy rather prominent hills and ridges in the lower foothills, mainly north of the Kings River. Outcrops of parent rock are generally dark colored, low lying, and angular in shape. They are not a prominent feature of the soil landscape.

These soils are at elevations of 400 to 1,800 feet. According to elevation, the average annual precipitation ranges from 14 to 18 inches, the average annual temperature from 62° to 59° F., and the average growing season from 225 to 250 days. The natural vegetation consists mainly of annual grasses and forbs. There are open stands of blue oak on northerly slopes or in protected areas.

In a typical profile, the surface layer is neutral, brown fine sandy loam about 9 inches thick. The subsoil is about 5 inches thick; it is reddish brown fine sandy loam that is neutral and shows evidence of clay accumulation. It grades abruptly into fractured and partly weathered parent rock at a depth of about 14 inches. There is a thin litter of dried grass, forbs, and oak leaves on the surface.

The Millerton soils are used principally for range. Water for livestock and for domestic use is obtained from a few springs and from intermittent streams. Small dams on some of these streams help to save water for use for livestock. Reliable sources of water are not available for sprinkler irrigation of pastures on gentle slopes.

Representative profile in rangeland supporting annual grasses, forbs, and an open stand of blue oak in the lower Sierran foothills, on an east-facing slope of 20 percent, at an elevation of about 625 feet (5¾ miles, airline, NW. of Academy; SE¼SW¼ of sec. 30, T. 11 S., R. 22 E.):

A11—0 to 2 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 3/4) when moist; massive to weak, fine, granular structure; slightly hard when dry, very friable when moist; plentiful fine and very fine grass roots; many fine and very fine interstitial pores; neutral (pH 6.7); abrupt, wavy lower boundary.

A12—2 to 9 inches, brown (7.5YR 4/4) fine sandy loam, dark brown (7.5YR 3/4) when moist; massive; hard when dry, very friable when moist; plentiful fine roots, few medium roots, few fine and medium tubular pores, few very fine interstitial pores, neutral (pH 6.8), abrupt, wavy lower boundary.

B2t—9 to 14 inches, reddish-brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) when moist; massive to weak subangular blocky structure, hard when dry, friable when moist, slightly sticky when wet, plentiful fine roots, few medium roots, few fine tubular pores, few very fine interstitial pores, many thin clay films in pores and as bridging and mineral grain coatings, few thin clay films on some ped faces; neutral (pH 7.0); abrupt, irregular lower boundary.

R—14 inches +, dark-gray hornblende schist, slightly weathered surfaces streaked with yellow, brown, and reddish yellow; thin, discontinuous clay films coat the upper surface of the rock and finger down steeply dipping fracture planes, some fine and very fine grass roots penetrate these narrow openings for a few inches, grades to unweathered rock within a few feet.

The surface of the soil described in the foregoing profile is covered with a thin, discontinuous litter of material from dried grasses and forbs, as well as some oak leaves.

The dry color of the A horizon is commonly brown (7.5YR 5/4), but in places it is brown (10YR 5/3) or reddish brown (5YR 4/4). The moist color is generally dark brown (7.5YR 3/4); in places, however, it is reddish brown or dark reddish brown (5YR 4/3, 3/4). The A horizon is generally massive, but where it is undisturbed by trampling a thin granular A11 horizon remains. This thin horizon generally has a higher content of organic matter. Reaction of the A horizon is mainly slightly acid to neutral but is medium acid in places.

The B2t horizon is weakly developed. Texture ranges from fine sandy loam to loam. Dry color is normally reddish brown (5YR 5/4, 4/4), but it tends toward yellowish red in places. The B2t horizon is massive or has weak structure ranging from subangular to angular blocky. Clay films are thin and few to common on ped or pore faces. Reaction of the B2t horizon is neutral to slightly acid. A few detached, angular fragments of parent rock occur in the solum. The solum ranges in thickness from 6 to 23 inches but is generally thicker than 10 inches and thinner than 20 inches. The subsurface relief of the underlying parent rock is very irregular.

Millerton fine sandy loam, 9 to 30 percent slopes (MnD).—This soil is mainly in the area of Owens Mountain. It has the profile described as typical for the series. Some of the acreage is located near Round Mountain, and a small area is located near Squaw Valley. The soil is rolling to hilly. Many gophers and other burrowing animals are active in areas of this soil. The numerous tailings of subsoil material generally give the impression that the surface layer is redder than it actually is. The dominant slopes in each area of this soil range either from 9 to 15 percent or from 15 to 30 percent. Some very limited areas show slight sheet and rill erosion. In some places there are a few rock outcrops.

The soil is well drained. Runoff is medium to rapid, and the hazard of erosion is moderate to high. The permeability of the soil is moderately rapid, and surface water is absorbed readily when the soil is dry. However, because of its shallowness, the soil is soon saturated and runoff is to be expected. Steeply dipping fracture planes in the parent rock help to drain away some of the excess water internally. The available water holding capacity is very low.

Included with this soil in mapping were similar soils that have a surface layer that is darker than normal when moist, and some areas of a similar soil having a loam surface layer. Also included were small areas of Honcut and Los Robles soils, which lie in small swales or along small drainageways. There are also some small areas of Blasingame and Friant soils included.

Millerton fine sandy loam, 9 to 30 percent slopes, is used for grazing. It is well suited to this use, and with continuing good management, it produces fair to good growth of forage during favorable years when rainfall is near normal and is well distributed throughout the growing season. Moderate to good response of grasses can be obtained by applying nitrogen fertilizer. Studies made on terrace soils derived from similar parent material show the response of grasses to phosphorus is less, and the response of grasses and legumes to sulfur is uncertain (unpublished range fertility trial records, University of California Agricultural Extension Ser-

vice, Fresno, California). The soil is too shallow for successful dryfarming of barley or grain-hay on the less steep slopes. If sources of irrigation water become available, the more gently sloping areas are suitable for pasture irrigated by sprinkler.

Minor deposits of copper and iron minerals, largely chalcopyrite and some malachite and pyrrhotite, are found in places in the parent rocks of this soil. The old Fresno Copper Mine, now abandoned, is situated in an area of this soil west of Owens Mountain. Here, several acres have been rendered sterile from copper salts leached by rain and surface water from the mine openings and tailings. Capability unit VIe-41 (18); range site 5; natural land type E5; Storie index rating 27.

Millerton fine sandy loam, 30 to 45 percent slopes (MnE).—This steep soil is similar to Millerton fine sandy loam, 9 to 30 percent slopes, but occupies rounded hills and ridges mainly in the vicinity of Owens Mountain. Small areas of the soil are also located northeast of Round Mountain and north of Squaw Valley. A small area of similar, but deeper, soils has been included. Runoff is rapid, and the erosion hazard is high.

This soil is used entirely for range and is well suited to this use. Its management is similar to that of Millerton fine sandy loam, 9 to 30 percent slopes. Although the slopes are steeper, much of the acreage of Millerton fine sandy loam, 30 to 45 percent slopes, is accessible, and fertilization, particularly with nitrogen, is practical. Fertilization is particularly helpful in eroded spots to reestablish a protective and more usable cover on the soil. The soil comprises significant parts of some small watersheds. Capability unit VIe-41 (18); range site 5; natural land type E13; Storie index rating 13.

Millerton fine sandy loam, 45 to 70 percent slopes (MnF).—This very steep soil is on Owens Mountain and on ridges southwest of Humphreys Station. Its profile is similar to that described as typical for the series. Runoff is rapid, and the erosion hazard is very high.

Included in mapping were small areas where the surface layer is loam. On Owens Mountain there are included stringers of colluvial material in which soils similar to the Blasingame series have developed.

Millerton fine sandy loam, 45 to 70 percent slopes, is used for range. It also makes up the upper parts of several small watersheds. Because of the very steep slopes, the forage is not intensively used by grazing animals. The development of stock trails and planned location of salt licks aid in better distribution of livestock throughout the areas of this soil. Fertilization is not practical, because the very steep slopes make application difficult and costly. Capability unit VIIe-4 (18); range site 5; natural land type E18; Storie index rating 7.

Millerton fine sandy loam, 45 to 70 percent slopes, eroded (MnF2).—This soil has been considerably affected by sheet erosion and rill erosion. Otherwise, the profile is similar to that described as typical for the series. The soil is almost entirely on south-facing sides of prominent, very steep ridges. On these slopes are many parallel drainageways. In many of these drainageways, the nearly straight channels are being overdeepened. Other drainageways appear to be stabilized.

The surface layer is reddish-brown fine sandy loam. The soil material, particularly in the middle and upper parts of the slopes, is generally no deeper than 10 to 12 inches. Some erosion pavement composed of angular fragments of parent rock has formed in places. The cover of annual grasses and forbs is poorer than that on similar soils that are not eroded. Some giant lupine shrubs have established themselves in some places. Runoff is very rapid, and the hazard of erosion is very high. Included are some areas in which the surface layer is loam.

The soil is used for range. Because of the erosion, the forage production is poorer on this soil than on Millerton fine sandy loam, 9 to 30 percent slopes. Even though the steep slopes tend to reduce the intensity of use by livestock, grazing should still be regulated to help in the regeneration of a better grass cover. Capability unit VIIe-4 (18); range site 5; natural land type E13-3m; Storie index rating 3.

Millerton rocky fine sandy loam, 3 to 30 percent slopes (MoD).—Except that rock outcrops occupy from 2 to 25 percent of the surface area of this soil, the profile is similar to that described as typical for the series. Most of the acreage is in the vicinity of Owens Mountain. A small area lies northeast of Round Mountain.

This soil is used only for grazing and is well suited to this use. Forage production is only slightly diminished because of the surface rockiness. Tillage of the less steep slopes is difficult or impractical because of the rockiness. With adequate moisture, forage production increases significantly by using nitrogen fertilizers. Capability unit VIs-41 (18); range site 5; natural land type E8; Storie index rating 16.

Millerton very rocky fine sandy loam, 30 to 45 percent slopes (MoE).—The profile of this soil is similar to that described as typical for the series, but 2 to 10 percent of the surface is occupied by rock outcrops. This steep soil is on prominent ridges and hills in the vicinity of Owens Mountain and also west of Humphreys Station. Runoff is rapid, and the hazard of erosion is high.

The use and management of this soil are similar to those of Millerton rocky fine sandy loam, 3 to 30 percent slopes. However, the slope tends to reduce the intensity of grazing. Fertilization is not practical. Capability unit VIIs-8 (18); range site 5; natural land type E16; Storie index rating 8.

Millerton very rocky fine sandy loam, 45 to 70 percent slopes (MoF).—The profile of this unit is similar to that described as typical for the series, but the soil is very steep, occupies mountainous areas, and has outcrops of parent rock that occupy 2 to 50 percent of the surface area. The soil is located only on Owens Mountain. The steeper areas are more rocky than the other areas. Runoff is very rapid. The hazard of erosion is generally very high, but it varies locally.

depending on the size and location of the rock outcrops.

This soil is used only for grazing and the upper parts of several small watersheds. The very steep slopes diminish the intensity of use by grazing animals. Stock trails and planned distribution of salt licks improve distribution of the grazing animals and the utilization of available forage. Fertilization is not practicable. Capability unit VIIs–8 (18); range site 10; natural land type E16; Storie index rating 3.

Montpellier Series

The Montpellier series consists of well-drained soils that have a coarse sandy clay loam subsoil. The soils formed in coarse-textured granitic sediments exposed to weathering through slow erosional dissection of old alluvial terraces deposited mainly by the San Joaquin River. These soils are undulating to hilly, and their surface is smooth. Slopes are 9 to 30 percent. The soils are mainly between Pinedale and Friant. Most of the acreage of these soils in this survey area are mapped as complexes with soils of the Pollasky series. These complex units are discussed under the Pollasky series.

The Montpellier soils range in elevation from 340 to 450 feet. The average annual rainfall ranges from 11 inches to 14 inches, the average annual temperature is 62° F., and the average growing season is 250 days. The natural vegetation consists of annual grasses and forbs.

In a typical profile, the Montpellier soils have a medium acid, pale-brown coarse sandy loam surface layer that is about 16 inches thick. The subsoil is brown to reddish-brown coarse sandy clay loam that overlies brown to light yellowish-brown loamy coarse sand at a depth of about 55 inches.

Montpellier soils are used mainly for dryfarmed small grains and for range or pasture. There are also some country homesites on these soils. Water for irrigation or domestic use is available only from wells.

Representative profile in a dry pasture of annual grasses and forbs, formerly dryfarmed to barley, on a north facing slope of 10 percent, at an elevation of about 390 feet (five-eighths mile N. of intersection of Copper and Willow Avenues, in the NE¼SE¼NE¼ of sec. 12, T. 12 S., R. 20 E.):

Ap—0 to 8 inches, pale-brown (10YR 6/3) coarse sandy loam, dark grayish brown (10YR 4/2) when moist; massive, hard when dry, friable when moist, nonsticky and nonplastic when wet; abundant very fine roots; common very fine tubular pores, many microsize interstitial pores, medium acid (pH 5.7), abrupt, smooth lower boundary.

A1—8 to 16 inches, pale-brown (10YR 6/3) coarse sandy loam, dark brown (10YR 4/3) when moist; massive, hard when dry, friable when moist, nonsticky and nonplastic when wet, plentiful very fine roots, many very fine tubular pores, many microsize interstitial pores; medium acid (pH 6.0), clear, wavy lower boundary.

B2t—16 to 55 inches, brown to reddish-brown (5YR to 7.5YR 5/4) coarse sandy clay loam, reddish brown (5YR 4/4) when moist; weak, coarse, angular blocky structure; very hard when dry, firm when moist, sticky and slightly plastic when wet; few very fine roots; many fine tubular pores; many thin to moderately thick clay films on ped faces; neutral (pH 7.3), diffuse, smooth lower boundary grading through a series of fibers ⅛ to 1 inch thick.

C—55 to 60 inches, brown to light yellowish-brown (10YR 5/3, 6/4) loamy coarse sand, brown (7.5YR 5/4) when moist; massive (single grain); hard when dry, very friable when moist, many fine interstitial pores; neutral (pH 7.0), many feet thick.

In some places the A horizon is brown, pale brown, or grayish brown. The hue is 10YR, the value is 5 or 6, and the chroma is generally 3 or 4. In some places where the value is 6, the chroma is only 2. Moist colors range from dark grayish brown to dark yellowish brown. The hue remains 10YR, but the value is only 4 and chroma ranges from 2 to 4. Texture of the A horizon is characteristically coarse sandy loam. The sand grains are angular to subangular in shape. The consistence is normally hard, but it is slightly hard in places. When moistened, the A horizon quickly becomes friable or very friable. The reaction ranges from near neutral to medium acid. The thickness of the A horizon ranges from about 4 to 20 inches, the thinner sites are in eroded areas.

The color of the B2t horizon is normally reddish brown (5YR 5/4) but is yellowish brown (10YR 5/4) or strong brown (7.5YR 5/6) in places. In many places reddish brown clay films coat peds that have a brownish colored matrix. The moist color is commonly reddish brown (5YR 4/4) but in places is dark yellowish brown (10YR 4/4). The coarse blocky structure of the B2t horizon appears weak, but common to many thin clay films are on faces of most displaced peds. Texture of the B2t horizon ranges from heavy coarse sandy loam to coarse sandy clay loam. Peds are very hard when dry and friable to firm when moist. The reaction of the B2t horizon is neutral or slightly acid. The thickness ranges from about 14 to 44 inches, and the horizon generally grades irregularly into the underlying C horizon. In places the transition to the C horizon is abrupt. In places are irregular masses of the parent material in the lower part of the B2t horizon. Tongues of the B2t horizon penetrate into the upper part of the C horizon in places, as well as through a series of progressively wider spaced, horizontal fibers.

Montpellier coarse sandy loam, 9 to 15 percent slopes (MpC).—The profile of this soil is very similar to that described as typical for the series. Areas of this soil are mainly northeast of Pinedale in the vicinity of Fort Washington golf course. They are near the bluffs bordering the secondary valley of the San Joaquin River. Runoff is medium, and the hazard of erosion is moderate to high. The slow permeability of the subsoil and the coarseness of the surface layer make the soil highly susceptible to erosion where it is not protected by an adequate cover of vegetation. The available water holding capacity is moderate.

Included with this soil in mapping were small areas of a similar soil having slopes of about 3 to 9 percent. One area is at the head of a small streamway that drains the terrace lands south of Fort Washington golf course. Two other small areas are north of Kirkman Hill near Centerville. It is probable that the parent material in the latter two areas came from the Kings River. Near Fort Washington golf course, another small area included with this soil shows slight to moderate sheet and rill erosion. The eroded areas can be repaired by disking.

This soil is used mainly for dryfarmed barley. It is also used for range and for some dry pasture. Country homesites are in some areas of this soil. Near Center-

ville, the less steep inclusions are planted to citrus. With adequate moisture, the growth of barley can generally be improved by adding nitrogen and phosphorus fertilizers to the soil. The forage grasses also respond to these fertilizers, but clovers and other legumes respond to sulfur applied in the form of gypsum or in superphosphate fertilizers. Erosion can be negligible if this soil is used as a well-managed range or pasture. Under dryfarming, the cleanly tilled seedbeds in fall or areas fallowed late in spring are susceptible to serious erosion. Cross-slope or contour preparation of the seedbed and stubble mulching fields in fallow help to minimize losses of soil. Because of the slopes and hazard of erosion, this soil is not well suited to irrigated row crops or cleanly tilled tree crops. The soil is adapted to irrigated pasture under sprinkler irrigation. Capability unit IVe-3 (17); range site 6; natural land type E3; Storie index rating 52.

Montpellier coarse sandy loam, 15 to 30 percent slopes (MpD).—This hilly soil is similar to Montpellier coarse sandy loam, 9 to 15 percent slopes, but has formed on the dissected parts of the terraces bordering the bluffs along the secondary valley of the San Joaquin River. The soil is in several areas from the vicinity of Pinedale to the vicinity of Little Dry Creek, south of Friant. Runoff is medium to rapid; the hazard of erosion is high.

Near Fort Washington golf course, a small area included in mapping shows moderate sheet erosion and shallow gullies.

This soil is used mainly for dryfarmed grain or for grazing. A small area has been planted to citrus, and another area makes up part of the golf course. The general management of this soil is similar to that of Montpellier coarse sandy loam, 9 to 15 percent slopes. There is an increased need for erosion control measures if the cover of vegetation is removed during the rainy season. Capability unit VIe-3 (17); range site 6; natural land type E3; Storie index rating 46.

Mt. Olive Series

The Mt. Olive series consists of well-drained, highly calcareous, clay soils that are moderately deep to very strongly weathered rock. These soils formed from the weathering of gabbro diorite rocks exposed along the lower edge of the foothills. They are smooth and undulating to rolling. In some areas these soils occupy small knolls that stand slightly above surrounding soils formed in old valley fill material. There are no outcrops of rock in areas of these soils.

Mt. Olive soils are in the vicinity of Round Mountain, Jesse Morrow Mountain, Campbell Mountain, and Mt. Olive at elevations of 400 to 600 feet. The average annual rainfall is 14 to 15 inches. The average annual temperature is 62° F., and the average growing season ranges from 260 to 275 days. The natural vegetation consists entirely of annual grasses and forbs, many of which are clovers.

In a typical profile, the surface layer is grayish-brown, calcareous clay, about 16 inches thick. The next layer is brown, calcareous clay. At a depth of about 25 inches is strongly calcareous, white sandy clay loam. This layer is over very strongly weathered gabbroic parent rock that is moderately calcareous.

Mt. Olive soils are used for range and for dry pasture. Irrigated crops are grown in some areas where water is available. Some irrigation water has been obtained from wells drilled into the underlying weathered rock, but most is pumped from wells in nearby valley fill.

Representative profile in a pasture of annual grasses and forbs, on a south-facing slope of 8 percent, at an elevation of about 475 feet (about 3 miles, airline, NW of Navelencia in the NW¼SE¼NE¼ of sec. 13, T. 14 S., R. 23 E.):

A11—0 to 9 inches, grayish brown (10YR 5/2) light clay, very dark grayish brown (10YR 3/2) when moist; strong, medium to coarse, subangular blocky structure; slightly hard when dry, friable when moist, sticky and slightly plastic when wet; plentiful fine and very fine roots, common fine tubular pores and few coarse random burrows; common pressure faces not slickensided, occasional parent rock fragments; moderately calcareous, mainly disseminated lime but a few, fine, hard nodules, mildly alkaline (pH 7.6); abrupt, wavy lower boundary.

A12—9 to 16 inches, grayish-brown (10YR 5/2) clay, dark brown (10YR 3/3) when moist; weak, medium to coarse, subangular blocky structure parting to fine granular structure; slightly hard when dry, friable when moist, sticky and slightly plastic when wet; plentiful fine and very fine roots; many very fine and fine tubular and interstitial pores; common pressure faces on peds not slickensided; occasional parent rock fragments; moderately calcareous, many very fine threads of segregated lime; mildly alkaline (pH 7.6); clear, wavy lower boundary.

A13—16 to 25 inches, brown (10YR 5/3) clay, brown (7.5YR 5/4) when moist, weak, medium to coarse, subangular blocky structure; slightly hard when dry, friable when moist, sticky and slightly plastic when wet; plentiful fine and very fine roots; many fine and very fine tubular pores, many microsize interstitial pores; common pressure faces on peds not slickensided; moderately calcareous, many very fine threads of segregated lime; mildly alkaline (pH 7.6); very abrupt, irregular lower boundary.

C1ca—25 to 35 inches, white (10YR 8/2) sandy clay loam, light gray (10YR 7/2) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet, scattered clusters of fine roots follow cracks and small burrows filled with soil material from above; few fine tubular pores; strongly calcareous, common, medium to coarse lime seams, moderately alkaline (pH 7.8); abrupt, wavy to irregular lower boundary.

C2—35 to 60 inches, variably colored, white, light-gray, dark-gray, very strongly weathered gabbroic parent rock with distinct, fine yellowish-red mottles, original rock fabric still recognizable; very hard when dry, friable when moist, many microsize interstitial pores between weathered mineral grains; moderately calcareous, common, medium to coarse irregular lime accumulations, grades with depth to unweathered parent rock.

Depth to the C1ca horizon ranges from about 24 to 30 inches. The color of the A horizon ranges from grayish brown (10YR 5/2) to dark gray (10YR 4/1) or, in places, dark brown (10YR 4/3). Moist colors are very dark gray, very dark grayish brown, or dark brown (10YR 3/1, 3/2, 3/3). Lime is generally disseminated and is slightly to strongly effervescent when dilute acid is applied. A few fine lime nodules are variably distributed in the A horizon. The shrink-swell character of the clay tends to maintain a blocky or granular structure in the A horizon.

The color of the A12 and A13 horizons, below a depth of 12 inches, is similar to that of the A11 horizon, but in places it is one or two units greater in value or chroma when moist or dry. The quantity of both disseminated and segregated lime increases with depth. The reaction is mildly to moderately alkaline, and the soil material is moderately to violently effervescent when dilute acid is applied. The segregated lime appears commonly in the form of fine, mycelial-like threads; some is in the form of fine or medium nodules.

The Cca horizon varies somewhat in thickness and generally has a very light-colored, marly appearance. The strongly weathered parent rock that comprises the C2 horizon is many feet thick. A few boulders having rounded outer shells of decomposition are enclosed in the weathered rock material.

Mt. Olive clay, 9 to 15 percent slopes (MtC).—This rolling soil is on the foot slopes of Jesse Morrow Mountain, on the lower westerly and southerly slopes of Round Mountain, and in the vicinity of Holland Creek southeast of Round Mountain. It has a profile very similar to that described as typical for the series. Runoff is medium, although it is slow early in the rainy season until the soil swells and closes the many deep cracks that formed during the dry period of summer. The permeability of the moist soil is slow. The available water holding capacity is moderate to high. The erosion hazard is moderate. Slopes in fill areas or road cuts can slump badly, however, if the soil is saturated with water.

The clay tends to aggregate readily and maintains a granular or fine subangular blocky structure on repeated wetting and drying. However, excessive trampling by grazing animals can develop a fairly persistent coarse platy hoofpan a few inches below the surface. This hoofpan restricts water penetration.

The principal use of this soil is for range. The soil is well suited to this use and can be developed into good dry pasture. Range grasses are likely to respond well to nitrogen fertilizer, but the response to phosphorus is uncertain. Legumes are common on the soil, and they may respond to sulfur.

The soil can be tilled easily compared to other clay soils. Some areas are used for citrus and for dry-farmed grain cut for hay. The citrus, both oranges and grapefruit, are irrigated by low-set sprinklers. Some trees show symptoms of iron chlorosis, but much less than might be expected from the high lime content of the soil. Some evidence of magnesium deficiency has also been seen in citrus. Capability unit IIIe-5 (17); range site 3; natural land type E2; Storie index rating 42.

Mt. Olive clay, 3 to 9 percent slopes (MtB).—This soil is similar to Mt. Olive clay, 9 to 15 percent slopes, but occupies low knolls or footslopes on outlying hills or mountains along the lower edge of the foothills. It is in several small areas on a low knoll northwest of Round Mountain, on slopes skirting Round Mountain, and on low hills northeast of Centerville. It also comprises all of Mt. Olive west of Orange Cove. The hazard of erosion is slight, but road cuts can slump badly if the soil is saturated.

Included with this soil in mapping was a small area of a similar soil formed from old calcareous sediments. This included soil adjoins the lower slopes of Jesse Morrow Mountain near the crossing of Kings Canyon Road and the Alta Irrigation District canal.

The use and management of Mt. Olive clay, 3 to 9 percent slopes, are similar to those of Mt. Olive clay, 9 to 15 percent slopes. Tomatoes are grown in the area that makes up Mt. Olive. Capability unit IIIe-5 (17); range site 3; natural land type E2; Storie index rating 44.

Nord Series

The Nord series consists of well to moderately well drained, loam soils that formed in recent alluvium derived mainly from basic igneous rocks and metamorphic basic igneous rocks. These soils are nearly level on flood plains of several small streams along the lower edge of the foothills draining parts of the San Joaquin Valley. In the Valley the flood plains are within small, slightly entrenched secondary stream valleys.

The soils are at elevations of 375 to 650 feet. With increasing elevation, the average annual precipitation ranges from 12 to 16 inches. The average annual temperature is about 62° F., and the average frost-free season is about 275 days. The natural vegetation consists of annual grasses and forbs. Saltgrass and other tolerant plants grow in saline-alkali affected areas of these soils.

In a typical profile, the surface layer is brown, mildly alkaline loam about 5 inches thick. The subsurface layer, about 10 inches thick, is similar in texture and color. It overlies brown, moderately alkaline, calcareous loam that extends to a depth of about 44 inches. Below this is brown and light gray, calcareous clay loam.

The Nord soils have been used principally for range or dry pasture, mainly because of their location and association with other rangeland soils and because of limited sources of irrigation water. Some surface water is seasonally available in local small streams. Shallow wells have been dug to supply water for livestock. The soils are in a zone of relatively low frost hazard. If reliable sources of irrigation water are developed and the excess salts and alkali are removed, these soils will make good cropland.

Representative profile on the very gently undulating flood plain of Holland Creek, in an area of range under a dense cover of annual grasses, forbs, and some saltgrass, at an elevation of about 570 feet (approximately 3⅞ miles, airline, WSW. of the Piedra Post Office in the NE¼ of sec. 14, T. 13 S., R. 23 E.).

O1—A thin, discontinuous litter of dried grass and parts of forbs.

A11—0 to 5 inches, brown (7.5YR 4/2) loam, very dark brown (7.5YR 2/2) when moist; weak, medium, subangular blocky structure breaking readily to fine granular structure, slightly hard when dry, very friable when moist, slightly sticky when wet; very abundant fine roots and [illegible] stocks, mildly alkaline (pH [illegible]); abrupt, smooth lower boundary.

A12—5 to 15 inches, brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) when moist; massive; soft when dry, very friable when moist, slightly sticky when wet; abundant fine roots, many very fine and microsize interstitial pores; slight amounts of disseminated lime; moderately alkaline (pH 8.4); clear, smooth lower boundary.

AC—15 to 19 inches, brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) when moist; massive; soft when dry, very friable when moist, slightly sticky when wet; plentiful fine roots; many very fine and microsize interstitial pores; strongly calcareous with disseminated lime; moderately alkaline (pH 8.4); gradual, smooth lower boundary.

C1ca—19 to 44 inches, brown (10YR 5/3) loam, dark brown (7.5YR 4/3) when moist; massive; slightly hard when dry, very friable when moist, slightly sticky when wet; very few fine roots; few fine tubular pores, many very fine and microsize interstitial pores; strongly calcareous with disseminated carbonates; very strongly alkaline (pH 9.4); abrupt irregular lower boundary.

IIC2ca—44 to 56 inches, brown (7.5YR 5/2) clay loam, dark brown (7.5YR 3/2) when moist; massive; hard when dry, firm when moist, sticky and plastic when wet; common very fine and microsize interstitial pores; very strongly calcareous with disseminated and some segregated carbonates in small nodules; strongly alkaline (pH 8.8); gradual, smooth lower boundary.

IIC3ca—56 to 65 inches +, light-gray (5YR 6/1) clay loam, dark gray (5YR 4/1) when moist; massive; hard when dry, friable when moist; sticky and plastic when wet; very strongly calcareous with disseminated lime; moderately alkaline (pH 8.2).

The texture of the A horizon and C horizon is commonly loam. Little or no stratification with coarser or finer textured materials occurs, except where a moderate thickness of parent material has been deposited over an unrelated, finer textured IIC horizon. The A horizon is generally brown grading to dark brown (10YR 4/3; 7.5YR 4/2, 5/2); moist colors are dark brown or very dark brown (7.5YR 2/2, 3/2). The C horizon is also brown, but slightly lighter or brighter (10YR 5/3; 7.5YR 5/4, 6/3); when moist, the color is dark brown to dark reddish brown (7.5YR 3/2, 3/4; 5YR 3/3, 3/4).

The A horizon is massive or has subangular blocky or weak granular structure. The A and C horizons have a soft or slightly hard consistence when dry. Considerable accumulation of disseminated lime is normally found in the C horizons. The A horizon is generally noncalcareous but is slightly calcareous in places. The A horizon ranges from neutral to strongly alkaline, whereas the C horizon ranges from moderately alkaline to very strongly alkaline. The strongly or very strongly alkaline reaction is in areas of the soil that are saline-alkali affected. In places there are indistinct yellowish or reddish mottles at a depth of more than 4 feet.

Nord loam, saline-alkali (0 to 2 percent slopes) (Nr).—This soil is mainly in the valley cove of Holland Creek northeast of Centerville. Smaller areas are located along Fancher Creek and Redbank Slough near Round Mountain. The soil is saline-alkali affected. About half of the acreage is affected only in the material underlying the surface layer; the rest of the acreage is affected in the underlying material and spottily affected in the surface layer. Where the soil is saline-alkali affected, the reaction is strongly to very strongly alkaline and in some places there is a slight accumulation of neutral and basic salts. The unrelated, finer textured part of the underlying material is variable in its occurrence. Where this part is present, the internal drainage of the soil is slowed but not seriously impeded.

The soil is moderately well drained. The runoff is slow, and the permeability is moderate. The hazard of erosion is none to slight, except for areas in which there is flooding, minor channeling, and deposition from uncontrolled small streams draining the lower foothills. After the soil is reclaimed, the available water holding capacity is high. The roots of most plants cannot grow well in the saline-alkali affected layers.

Included with this soil in mapping was a minor area of a similar soil that has a channeled surface. Also included were some areas that have a surface layer of fine sandy loam.

Nord loam, saline-alkali, has been used mainly for range or dry pasture. It produces good growth of shallow-rooted forage plants, particularly where it is only saline-alkali affected in the underlying material. Saltgrass provides some forage value. Fertilization is questionable. If a dependable supply of irrigation water is available, the soil must first be reclaimed for successful cropping. With proper management, the soil is readily reclaimable. See the section "Saline and Saline-Alkali Soils" for a discussion of methods of reclamation used. Under conditions of incomplete reclamation, the soil supports excellent irrigated pasture. If it is completely reclaimed, the soil is suited to citrus, vineyards, and many field crops. Its value is enhanced by its location in the zone of minimum frost hazard along the edge of the foothills. Capability unit IIs 6 (17); range site not assigned; natural land type A1–2s; Storie index rating 60.

Nord loam (No).—This soil is free of excess salts and alkali. It is in small areas from the vicinity of the Dry Creek Flood Control Dam southeastward to Clark Valley.

Included with this soil in mapping were small areas of a similar soil having an irregularly channeled surface. Also included were small areas of a similar soil that overlies a hard substratum at a depth ranging from 30 to 48 inches. The substratum resembles the less strongly cemented parts of the hardpan and substratum underlying the Yokohl soils. Among these included areas is one that is also saline-alkali affected in the material between the surface layer and the substratum. There are also some included areas where the surface layer is fine sandy loam. These included areas are behind the Dry Creek Flood Control Dam, along Redbank Slough near Ashlan Ave., and at the mouth of Holland Creek. The included areas, which overlie an unrelated substratum, have a more restricted internal drainage and are seasonally saturated in the underlying material for short periods of time. The substratum is slowly permeable, but it contains cracks that help to drain away excess water. Some areas are subject to flooding from uncontrolled small streams.

Because Nord loam is in slightly depressed positions along streamways cutting across the terraces, it receives some runoff from adjacent higher lying areas. Runoff on this soil is slow. The available water holding capacity is high. The hazard of erosion is none to slight.

This soil is used mainly for grazing. The individual areas of the soil are generally too small to use independently but are intermingled with large areas of poorer soils suited to range. The soil is suitable for use as dry pasture. Growth of forage is good and can be readily improved by applying nitrogen fertilizers. Little of this soil is located where dependable sources of irrigation

water are available. Where water is available, the soil is capable of producing good growth of field crops, vineyards, and citrus. Capability unit I-1 (17, 18); range site not assigned; natural land type A1; Storie index rating 100.

Pachappa Series

The Pachappa series consists of well-drained soils that formed in medium-textured and moderately coarse textured granitic alluvium. These soils are generally smooth and nearly level. They are well drained and moderately well drained, and in some places they are saline-alkali affected. The soils are mainly on the alluvial plains of Dry Creek and Fancher Creek, near Fresno and Kearney Park, as well as on the alluvial plains of several small streams in the Orange Cove district. Some areas of the soils are also near Laton and Raisin City.

Pachappa soils are at elevations of 200 to 460 feet. The average annual precipitation ranges from 8 to 15 inches, the average annual temperature is about 62° F., and the average growing season ranges from 225 to 250 days. The natural vegetation is mainly annual grasses and forbs, and there are some saline- and alkali-tolerant plants in affected areas.

In a typical profile, the surface layer is grayish-brown, mildly alkaline loam about 4 inches thick. The upper part of the subsoil is brown light clay loam, moderately alkaline, and about 15 inches thick. The lower part of the subsoil is brown to yellowish-brown loam about 6 inches thick. This is underlain by yellowish-brown loam and pale-brown silt loam. Both the lower subsoil and the underlying material are calcareous.

Most areas of these soils are cultivated. The soils are used mainly for field crops. Some areas are planted to vineyards, fruit trees, and some truck crops. Water for irrigation is obtained from wells and from irrigation district canals.

Representative profile in a leveled field planted to alfalfa, at an elevation of 250 feet (about 1¼ mile, air line, ESE of Kearney Park, 500 feet N. and 100 feet W. of the junction of Hayes and Church Avenues in the E½SE¼NE¼ of sec. 16, T. 14 S., R. 19 E.):

Ap—0 to 4 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; massive, slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant very fine roots, many very fine tubular pores; mildly alkaline (pH 7.8); abrupt, smooth lower boundary.

B2t—4 to 19 inches, brown (10YR 5/3) light clay loam, dark brown (10YR 4/3) when moist; moderate, medium, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant very fine roots, few fine roots, many very fine tubular pores; common thin clay films in pores and on ped faces; slightly calcareous with lime in fine seams; moderately alkaline (pH 8.0); gradual, smooth lower boundary.

B3—19 to 25 inches, brown to yellowish brown (10YR 5/3, 5/4) loam, dark brown (10YR 3/3) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful very fine roots, few fine roots; many very fine tubular pores; common thin clay films in pores; slightly calcareous with lime in fine seams; moderately alkaline (pH 8.0); gradual, smooth lower boundary.

C1—25 to 42 inches, yellowish-brown (10YR 5/4) loam, brown (10YR 4/3) when moist; massive, slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; plentiful very fine roots, few fine roots, many very fine tubular pores; slightly calcareous with segregated lime in seams and soft spots; moderately alkaline (pH 8.0); abrupt, smooth lower boundary.

IIC2—42 to 60 inches +, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) when moist; massive, very hard when dry, firm when wet; strongly calcareous with disseminated and segregated lime; moderately alkaline (pH 8.3).

The A horizon ranges from brown to grayish brown (10YR 5/3, 5/2); moist colors range from dark brown to very dark grayish brown (10YR 4/3, 4/2, 3/3, 3/2). Texture is loam to fine sandy loam. The A horizon is generally massive but in places has weak granular structure. Dry consistence ranges from hard to slightly hard. The reaction is predominantly mildly alkaline, but in places is moderately alkaline. In places lime is present as a result of deep tillage. The thickness of the A horizon normally ranges from about 8 to 14 inches. At the site of the representative profile, the A horizon has been truncated by leveling operations.

The color of the B2t horizon ranges from brown to yellowish brown (10YR 5/3, 5/4); moist colors range from brown or dark brown to dark grayish brown (10YR 4/3, 3/3, 4/2). The structure is weak or moderate, medium to coarse, subangular blocky. Texture ranges from light clay loam to heavy loam. Slight amounts of lime are typically present in disseminated or nodular form. Reaction is mildly alkaline to moderately alkaline.

In areas where a IIC horizon occurs, it is directly overlain by a B3 or a C horizon. If there is a IIC horizon, it is light gray, light brownish gray, or pale brown and has a texture of silt or silt loam. It is of variable thickness, is commonly fractured, and in places is stratified with loamy material. The depth to the IIC horizon ranges from about 24 to 48 inches. The IIC horizon impedes, but does not seriously restrict, the internal drainage of the soil. Roots do not penetrate the IIC horizon readily. In some areas that are saline-alkali affected, the reaction of the A horizon and B2t horizon is strongly alkaline to very strongly alkaline.

Pachappa loam, moderately deep (Pd).—The profile of this soil is very similar to the one described as representative for the series. This soil is mainly on the intermingled, smooth alluvial plains of both Dry Creek and Fancher Creek.

Runoff is slow. The permeability of the soil is normally moderate, but it may become slow where tillage pans are formed. The substratum can cause a temporary perching of excess drainage water. The available water holding capacity is high.

Included with this soil in mapping were small areas of similar soils that are either less than 2 feet or more than 4 feet in depth to the silty substratum. Also included was a small area of a similar soil having a clay loam surface layer.

Field crops, vineyards, and some truck crops are grown on this soil. Peaches, however, are not well suited to Pachappa loam, moderately deep, because of the somewhat restricted internal drainage. Good management consists chiefly of maintaining fertility and controlling soil moisture. Nitrogen and phosphorus fertilizers are needed, as well as some sulfur. Continued cropping results in a need for potassium fertilizers, particularly if cotton is grown. The high available

water holding capacity of the soil permits fewer irrigations during a season, provided the water can enter the soil. Variation in depth of cultivation, deep chiseling and, where practical, use of cover crops with a fine root system are practices used to counter the packing of the surface layer and to encourage water penetration. Capability unit I–1 (17, 18); range site not assigned; natural land type A2; Storie index rating 70.

Pachappa loam (0 to 2 percent slopes) (Pa).—The profile of this soil lacks a restricting substratum within 6 feet or more of the surface. This soil is similar to but is somewhat more readily drained than Pachappa loam, moderately deep, and temporary perching of saturated zones does not occur. The soil is widely distributed in small areas near Orange Cove, Centerville, Clovis, Fresno, and Kearney Park.

Some small areas of a similar soil having a sandy loam surface layer were included with this soil in mapping. Also included were areas where the surface layer is fine sandy loam.

The use and management of Pachappa loam are similar to those of Pachappa loam, moderately deep, but this soil is better suited to crops such as peaches, which are sensitive to temporary saturated conditions within the soil. Capability unit I–1 (17, 18); range site not assigned; natural land type A1; Storie index rating 95.

Pachappa loam, saline-alkali (0 to 2 percent slopes) (Pc).—This soil lacks a compact substratum at a depth of 6 feet or more. It is otherwise similar to Pachappa loam, moderately deep. The subsoil is strongly saline. About two-thirds of the acreage has from 5 to 33 percent of the surface layer similarly affected. The remaining third consists of areas that either are unaffected in the surface layer or have more than one-third of the surface layer affected.

This soil is widely distributed in small to medium-sized areas along small streams near the foothills in the vicinity of Academy, Centerville, and Orange Cove. Other areas are southwest of Kearney Park and near Raisin City and Laton. Areas of this soil near Laton are somewhat paler colored than other areas.

Included are some areas in which the surface layer is fine sandy loam.

The prospects of reclamation are good, providing proper management is used. Reclamation methods are discussed in the section "Saline and Saline-Alkali Soils." In the vicinity of Kearney Park, this soil and others like it to the south became saline-alkali near the turn of the century as a result of a rising water table following the first importation of surface water for irrigation.

Without irrigation, this soil is used for alkali pasture. Where it is irrigated but only partly reclaimed, it is used for irrigated pasture and for some alfalfa and cotton. If it is completely reclaimed, the soil has similar use potential and management requirements to those of Pachappa loam. However, continued care in water management, both for the soil and the locality, is needed in order to prevent the return of excess salts and alkali. These salts and alkali can accumulate if the local water table again rises to within 4 to 6 feet of the surface. Capability unit IIs–6 (17); range site not assigned; natural land type A1–2s; Storie index rating 57.

Pachappa loam, moderately deep, saline-alkali (Pe).—This soil is similar to Pachappa loam, moderately deep, but is saline-alkali affected. The surface layer is mainly unaffected by excess salts and alkali, but below a depth of about 15 inches the soil is strongly to very strongly alkaline and at least slightly saline. The soil is located mainly near alluvial deposits from Dry Creek and Fancher Creek southwest of Kearney Park. Also, a small area is northeast of Laton. This latter area is somewhat paler colored than normal for the series in this area.

Without irrigation, this soil is used for alkali pasture. Shallow-rooted field crops are well suited to this soil. With complete reclamation, the use and management of this soil are similar to those of Pachappa loam, moderately deep. The substratum, particularly the deeper layers below the effective depth for chiseling or ripping, tends to slow the complete reclamation of this soil. Excess salts and alkali persist in the deeper layers of the substratum. Capability unit IIs–6 (17); range site not assigned; natural land type A2–2s; Storie index rating 56.

Piper Series

The Piper series consists of deep, sandy loam soils formed under somewhat poorly drained conditions in granitic alluvium. The drainage has been improved, however, by lowering the water table. These soils occupy remnants of natural stream levees that rise 5 to 10 feet above the basin flood plain. Slopes are 0 to 9 percent. The remnants appear as short low ridges or knolls.

Piper soils range in elevation from 170 to 200 feet. The average annual rainfall is 8 inches, and the average annual temperature is about 63° F. The average growing season ranges from 225 to 275 days. The natural vegetation consists of saltgrass and salt-tolerant shrubs.

In a typical profile, the surface layer is grayish-brown, moderately alkaline sandy loam about 4 inches thick. This layer overlies light brownish gray sandy loam that is mottled, moderately alkaline, and strongly calcareous. The underlying material, at a depth of about 36 inches, is of similar color and texture and very strongly calcareous. The soils are normally saline-alkali affected.

When leveled and irrigated, the Piper soils are used mainly for cotton. In their natural state they are used for pasture, equipment sites, or homesites because of their relatively elevated position on the otherwise featureless basin flood plain.

Representative profile on a low knoll used as a homesite under a cover of saltgrass, at an elevation of about 185 feet (about 5 miles, airline, SE. of the town of San Joaquin; 1,750 feet S., 500 feet W. of the junction of Trinity and Rose Avenues in the SE¼SE¼ of sec. 4, T. 16 S., R. 17 E.):

A1—0 to 4 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) when moist, weak, fine, granular structure; slightly hard when dry, friable when moist, nonsticky and plastic when wet; abundant fine and very fine roots, few medium roots and rootstocks; slightly calcareous with disseminated lime, moderately alkaline (pH 8.2), abrupt, wavy lower boundary.

B21tca—4 to 18 inches, light brownish-gray (2.5Y 6/2) sandy loam, dark grayish brown (2.5Y 4/2) when moist, common, medium, distinct mottles of light gray (2.5Y 7/2) when moist; massive; very hard when dry (very weak lime cementation), firm when moist, nonsticky and plastic when wet; few fine roots; few thin clay bridge and grain coatings; strongly calcareous with disseminated lime; moderately alkaline (pH 8.4); abrupt, wavy lower boundary.

B22tca—18 to 36 inches, light brownish-gray (2.5Y 6/2) sandy loam, dark grayish brown (2.5Y 4/2) when moist; common, medium, distinct mottles of light gray (2.5Y 7/2) when moist, massive; hard when dry, friable when moist, nonsticky and plastic when wet; few fine roots, few thin clay bridges and grain coatings, but less than in C1ca horizon; strongly calcareous with disseminated lime; moderately alkaline (pH 8.4); gradual, smooth boundary.

B3ca—36 to 51 inches, light brownish-gray (2.5Y 6/2) sandy loam, dark grayish brown (2.5Y 4/2) when moist, few fine, faint mottles; massive; hard when dry, friable when moist, nonsticky and plastic when wet; few fine roots; very strongly calcareous with lime disseminated as well as segregated in fine, rounded, soft masses; moderately alkaline (pH 8.2); abrupt, irregular lower boundary.

C2ca—51 to 68 inches, light brownish-gray (2.5Y 6/2) sandy loam, dark grayish brown (2.5Y 4/2) when moist; common, fine, faint mottles; massive; hard when dry, friable when moist, nonsticky and plastic when wet; few fine roots; moderately calcareous with disseminated lime and few fine, rounded, soft masses; moderately alkaline (pH 8.2).

In undisturbed areas there is little variation in color of the A horizon. The A horizon is weakly granular or massive and has a dry consistence that ranges from hard to slightly hard. The reaction is commonly moderately alkaline but is strongly alkaline in places. Texture of the A horizon is fine sandy loam or sandy loam.

The color of the B and C horizons is variable—light gray, light brownish gray, or pale olive (2.5Y 7/2, 6/2; 5Y 6/3, 6/4); moist colors range from grayish brown, dark grayish brown, to olive (2.5Y 5/2, 4/2; 5Y 5/3). The B horizon is generally massive and may be hard or very hard when dry or friable to firm when moist. The lime is typically disseminated in the B horizon but is also in the form of many soft segregations in the C horizon. The spots of lime accumulation commonly produce whitish mottles. Other prominent mottles of reddish yellow or yellow also occur. In places below a depth of 60 inches the C horizon becomes stratified with layers of clay loam to clay. The upper part of the C horizon ranges from moderately alkaline to very strongly alkaline. With increasing depth below the B horizon the reaction becomes less alkaline. Soluble salts tend to be concentrated in the upper 36 inches of the profile.

Piper sandy loam, 0 to 9 percent slopes (PfB).—This soil is undulating or gently rolling on simple ridges or knolls. It has a profile that is very similar to that described as typical for the series. Most of the acreage is saline-alkali affected below the surface layer. This soil is distributed in small areas along the eastern part of the basin from the vicinity of Helm to Tranquillity. The lighter color of the surface layer and elevated position readily distinguish this soil from the darker colored, flat soils of the basin.

The general drainage of this soil has been altered through flood control and deep pumping for irrigation water. Runoff is medium to slow. Permeability is moderately rapid; consequently, the erosion hazard is slight. The available water holding capacity is moderate if the soil is fully reclaimed from its subsurface saline alkali conditions. Otherwise, the available water holding capacity is low because of the inability of roots to explore the whole depth of the soil.

The more gently sloping areas of this soil are generally leveled, reclaimed, and used with the more extensive basin soils for cotton, irrigated barley, and alfalfa seed. Some improvement can be obtained by spot treating the soil with additional nitrogen and phosphorus fertilizers and by adding organic residues.

Uncropped areas of Piper sandy loam, 0 to 9 percent slopes, are used as alkali pasture, equipment sites, and homesites. The soil should be partly reclaimed to permit reasonable landscaping around the homes. Tamarisk trees, alkali-tolerant shrubs, and saltgrass for lawns can be used if reclamation is not practical. The soil is readily reclaimed but it must be treated differently from the surrounding soils, most of which are finer in texture. Capability unit IIs-6 (17); range site not assigned; natural land type B1 2a; Storie index rating 51.

Piper fine sandy loam, 0 to 9 percent slopes (PgB).—This soil is in many small areas along the eastern edge of the basin flood plain, mainly east of San Joaquin. Permeability is moderate. More of the surface layer of this soil is saline-alkali than that of Piper sandy loam, 0 to 9 percent slopes, but it is otherwise similar. Included are some areas having a surface layer of light loam.

The use and management of this soil are similar to those of Piper sandy loam, 0 to 9 percent slopes. Unless the soil is reclaimed, growing crops is not economical. The reclamation of this soil, however, is somewhat slower than that of Piper sandy loam, 0 to 9 percent slopes. Capability unit IIs-6 (17); range site not assigned; natural land type B1-2a; Storie index rating 23.

Piper-Rossi complex, 0 to 9 percent slopes (PhB).—This mapping unit consists of Piper and Rossi soils that occur in such intricate patterns that it is impractical to separate the two soils at the scale used in mapping. The total acreage of the two soils is nearly equal. In the western part of the survey area, however, the Piper soil is dominant, whereas in the eastern part, the Rossi soil is dominant. The Rossi soil in this complex has a loam or fine sandy loam surface layer. Its profile is similar to that described as typical for the Rossi Series. The Piper soil has a profile similar to that described as typical for the Piper series.

This complex is made up of knolls and swales. The Piper soil occupies the low, flat-topped knolls; and the Rossi soil is in the swales. The Piper soil is saline-alkali affected throughout; the Rossi soil is affected only in its subsoil.

This complex has been used for many years as alkali pasture. It has recently been partly leveled, irrigated by sprinkler, and planted to cotton. Plant growth has been spotty. The Piper soil is readily reclaimable, but the Rossi soil is difficult to reclaim. Capability unit IVs-6 (17); range site not assigned; natural land type B1-2a and B2-2a; Storie index rating 30.

Pits (Pk) consists of open excavations from which soil material has been removed for use in construction or for earthfill and embankments. Most areas of this land type are pits dug below the general land surface, and these range in depth from about 5 to 20 feet. However, some are excised parts of terrace fronts or of side slopes of small hills. Most of the pits mapped are now idle. Some are basins for small seasonal ponds; others are sites for trash disposal.

Gravel pits are located mainly along the San Joaquin River and the Kings River. Most of these are in use and increasing in size as the sand and gravel are excavated. The pits used for aggregate sources in the construction of the Friant and Pine Flat Dams are now idle or have been converted to ponds and lakes for recreational use.

Borrow pits for earth materials are widely scattered in the San Joaquin Valley. These pits have provided materials ranging in texture from sand to clay loam for use in road building, for earth dam or levee construction, as fill for building sites, and for farming purposes.

The total acreage of Pits is small. A quarry near Piedra used for serpentine rock materials has been included. A standard mapping symbol is used to locate pits or quarries too small to be delineated separately. Capability unit VIIIw-4 (17); range site not assigned; natural land type A14; Storie index rating 5.

Playas (Pl) consists of small, flat-bottomed depressions, generally barren of vegetation and irregular in outline. They are widely distributed throughout the basin rim area and are intricately associated with saline-alkali affected soils. These depressions, or playas, range in size from about 2 to 20 acres and lie from 2 to 8 feet below the surface of the surrounding areas. They formed either from wind scouring or from the braiding of small alluvial stream ridges. The side slopes of the depressions, not mapped within areas of playas, are generally short and moderately sloping. Seasonally, these depressions become shallow ponds from surface runoff. The water remains until it evaporates.

The light-colored, generally white surface of a dry playa is normally level and smooth. Playas contain sediments, mainly strongly saline-alkali affected, that have accumulated in the depressions from local wash. These sediments are clay loam, silty clay loam, silty clay, or clay that in places are interbedded with thin layers of fine sand. The sediments range from 2 to 4 feet in thickness; in places they overlie coarse-textured material or firmly compacted layers of silt. When dry, the bare surface cracks into a reticulated pattern of polygonal blocks. The cracks are not wide, and when the blocks are lifted, they subdivide horizontally into platy fragments. The uppermost ones generally show a strong vesicular porosity. In places the surface is puffy from salt accumulation.

The smaller playas are generally bare of vegetation. The larger ones may include low mounds or ridges of fine sandy material accumulated by wind. These become somewhat stabilized by a sparse growth of saline-alkali tolerant plants. In many places, tiny erosional patterns are present on these mounds and on the side slopes of the depressions.

Many playas have been filled during leveling operations for reclamation of surrounding areas. Unless deeply ripped and mixed, these areas will act as impermeable subsurface lenses, making it very difficult to reclaim the overlying soil material. Where water is available, some playas have been used as ponds to attract migratory game birds. It has been suggested that the smooth hard surfaces of some of the larger areas would make excellent tracks for cart races, thus giving the playas some additional value for recreational use. Capability unit IVs-6 (17); range site not assigned; natural land type B17; Storie index rating 5.

Pollasky Series

The Pollasky series consists of well-drained soils that formed in place from the weathering of softly to moderately consolidated granitic sediments. At one time these sediments were overlain, at a moderate depth, by material laid down on alluvial terraces. Erosion has worn away the overlying material and exposed the granitic sediments to weathering and soil formation. In the process, an undulating to hilly relief has been formed that is smooth and rounded. Slopes are 2 to 30 percent.

These soils are widely distributed throughout the low alluvial terraces in the eastern part of the San Joaquin Valley. The largest acreage of these soils is located near the secondary valleys of the rivers.

Pollasky soils are at elevations of 300 to 500 feet. The average annual precipitation ranges from 11 to 15 inches, the average annual temperature is about 62° F., and the average growing season ranges from 250 to 275 days. The natural vegetation consists of annual grasses and forbs.

In a typical profile, the surface layer is brown sandy loam about 8 inches thick. This layer overlies a layer of slightly acid, pale-brown sandy loam about 26 inches thick. At a depth of 34 inches is light yellowish-brown sandy loam that is neutral. Light-brown or light yellowish-brown to very pale brown, moderately consolidated, sandy granitic sediments are at a depth of about 39 inches.

The Pollasky soils are used mainly for dryfarmed grain or for grazing. Where irrigation water is available, they are used for vineyards, some fruit trees, and field crops. Irrigation water is available mainly from wells. A part of the acreage, near Friant and north and east of Clovis, is in an area where the supply of ground water is limited.

Representative profile in a remnant of a natural area in a dryfarmed district, under a cover of annual grasses and forbs, on a northwest slope of 15 percent

at an elevation of about 400 feet (2,200 feet SE. of the junction of Willow Ave. and Friant Road at the east quarter corner, NE¼SE¼ of sec. 1, T. 12 S., R. 20 E.).

A11—0 to 3 inches, brown (10YR [illegible]) sandy loam, dark brown (10YR 3/3) when moist; moderate medium and fine, granular structure; slightly hard when dry, very friable when moist; nonsticky and nonplastic when wet; abundant very fine roots; slightly acid (pH 6.5); abrupt, wavy lower boundary.

A12—3 to 8 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) when moist; massive; hard when dry, friable when moist; nonsticky and nonplastic when wet; abundant very fine roots; many very fine and fine [illegible] pores; slightly acid (pH [illegible]); abrupt, smooth lower boundary.

C1—8 to 34 inches, pale brown (10YR [illegible]) sandy loam, dark brown (10YR 4/3) when moist; massive; hard when dry, friable when moist; nonsticky and nonplastic when wet; plentiful very fine roots; many medium and very fine tubular pores; slightly acid (pH [illegible]); clear, wavy lower boundary.

C2—34 to 59 inches, light yellowish brown (10YR [illegible]) sandy loam, dark brown (10YR [illegible]) when moist; massive; hard when dry, friable when moist; very slightly sticky and nonplastic when wet; few very fine roots; many fine and very fine interstitial pores; [illegible] fine tubular pores; many thin clay films on [illegible] pores; neutral (pH 7.1); abrupt, wavy lower boundary.

C3—59 to 69 inches, light brown (7.5YR 6/4) to light yellowish brown to very pale brown (10YR [illegible]), moderately [illegible] granitic sediments, dark yellowish brown (10YR 4/3, 4/4) or dark brown (7.5YR 4/4) when moist; massive; very hard when dry, very firm when moist; nonsticky and nonplastic when wet; very few, very fine random tubular pores; many microsize interstitial pores; many feet thick.

The color of the A horizon ranges from brown to pale brown (10YR 5/3, [illegible]). When moist the color is brown or dark brown (10YR 5/3, 4/3, 3/3). Texture of the A horizon is commonly sandy loam and fine sandy loam, but it ranges in places to coarse sandy loam. In fields that have been cultivated or trampled by grazing animals, the surface granular structure of the A11 horizon is destroyed and the A horizon is massive throughout. Consistence of the A horizon ranges from hard to slightly hard when dry, and friable to very friable when moist. It is seldom, if ever, sticky or plastic when wet. The reaction ranges from slightly acid to neutral.

The C1 and C2 horizons have a color similar to that of the A horizon, but in places it is slightly lighter or yellower. The dry color ranges from brown or pale brown to light yellowish brown (10YR 5/3, 6/3, 6/4); when moist, the color is generally dark brown or yellowish brown but in places light yellowish brown (10YR [illegible], [illegible], 6/4). The texture of the C1 and C2 horizons is essentially the same as the texture of the A horizon and the range in reaction is similar.

In places the upper part of the C horizon is very slightly sticky when wet. The gradation into the moderately consolidated, arkosic sediments that constitute the parent sediments is abrupt or clear. The parent sediments are either light brown to light yellowish-brown sandy material that is well compacted or weakly cemented, or they are light-gray, well-compacted fine sand, very fine sand, and silt.

Pollasky sandy loam, 9 to 15 percent slopes (PmC).—This rolling soil has a smooth surface and is made up of low rounded hills separated by narrow swales in which some colluvial soil material has accumulated. The parent material consists entirely of medium sandy sediments that are well compacted. Roots are generally unable to penetrate into these sediments. Depth to these compacted sediments ranges from about 20 to 40 inches. This soil has a profile that is similar to the one described as typical for the series. It is widely distributed in the terraces, and some areas are on the gentle terrace fronts that face the very extensive areas of the young fans.

Permeability is moderately rapid and runoff is medium. The hazard of erosion is moderate. The available water holding capacity is low to moderate.

This soil is used mainly for grazing and dryfarmed barley. The forage grasses respond well to nitrogen and phosphorus fertilizers. Clovers are stimulated by sulfur. The vegetative growth of dryfarmed barley is increased considerably by use of nitrogen and phosphorus, but there is little increase in the amount of grain produced. Under irrigation, the soil is used for growing raisin grapes and for sprinkler-irrigated pasture. The grapes are irrigated by short run furrows and contour furrows. Capability unit IVe-3 (17); range site 6; natural land type E1; Storie index rating 58.

Pollasky fine sandy loam, 2 to 9 percent slopes (PoB).—This soil occupies low, rounded knolls and gently sloping to moderately sloping terrace breaks, or gently beveled slopes of former distributary channels on the young fans of the rivers. It has a profile that is similar to that of Pollasky sandy loam, 9 to 15 percent slopes except for the slope and fine sandy loam texture. The parent sediments for this soil consist of compacted fine sand, very fine sand, and silt that are thinly laminated and generally micaceous. The hazard of erosion is slight. The available water holding capacity is low to moderate.

The soil is widely distributed in small areas near Reedley, Wahtoke, Del Rey, Selma, Friant, Herndon, Fort Washington golf course, and the mouth of Little Dry Creek. Individual areas of this soil have slopes that range either from 2 to 3 percent or from 3 to 9 percent.

Most of this soil is located where irrigation water is available, and the soil is near large areas of level soils intensively used for vineyards and for some fruit trees. Consequently, much of this soil has been used similarly. Some areas of the soil are idle. Some are used for grazing or dryfarmed barley, and management for these uses is similar to that for Pollasky sandy loam, 9 to 15 percent slopes. Raisin, table, and wine grapes are grown on this soil, as well as some oranges and figs. Vine crops are planted on the contour on some of the steeper areas but not on the less steep areas. In the less steep areas, irrigation furrows have short runs and are checked at intervals. Oranges have been planted where this soil occurs as a separate low knoll. Some protection from frost is gained by local air drainage from the higher position. Nitrogen and some phosphorus is used to fertilize the grapes and fruit trees. Capability unit IIIe-3 (17); range site 6; natural land type E1; Storie index rating 68.

Pollasky fine sandy loam, 9 to 15 percent slopes (PnC).—This soil occupies strongly sloping terrace fronts or sides of abandoned distributary channels on

the young fans of the rivers. Some areas are located between Herndon and Friant, and others are in the vicinity of Wahtoke, Reedley, and Parlier. This soil has a profile that is similar to that of Pollasky sandy loam, 9 to 15 percent slopes, except for the fine sandy loam texture. The parent sediments consist of compact, fine or very fine sand and silt that are generally thinly layered and micaceous. Included with this soil is a very small area of a generally similar soil that is clay loam in texture.

Pollasky fine sandy loam, 9 to 15 percent slopes, because of its position and the narrow winding shape of its areas, is generally idle or used for limited pasture. Where the soil is used for pasture, care should be taken to avoid overgrazing. The erosion hazard is moderate, and if there is not adequate cover, gullies can be started at the onset of the rainy season. If gullies do get started, they can cut back into adjacent, level soils that are better suited to crops. Gullies can also be caused by carelessly applied irrigation water on higher lying, adjacent soils. In places, border irrigation ditches are run along the upper edge of areas of this soil. If there are gophers or squirrels in idle areas below such ditches, there is a hazard of tunnel erosion where burrows may collapse and drain water from the ditch. Capability unit IVe-3 (17); range site 6; natural land type E1; Storie index rating 59.

Pollasky sandy loam, 2 to 9 percent slopes (PmB).—This soil is on low knolls surrounded by soils formed in younger alluvium. It is also on gently beveled terrace fronts and on some channel slopes. The profile of this soil is similar to that of Pollasky sandy loam, 9 to 15 percent slopes. Most of this soil is near Biola, Pinedale, Fort Washington golf course, Friant, Fowler, Selma, Del Rey, Reedley, and Orange Cove. The hazard of erosion on this soil is slight.

A small area of a similar soil that has a coarse sandy loam surface layer was included with this soil in mapping near the Fort Washington golf course.

The use and management of Pollasky sandy loam, 2 to 9 percent slopes, are similar to those of Pollasky fine sandy loam, 2 to 9 percent slopes. Most of the acreage is in areas well supplied with water for irrigation and intensively developed for irrigated crops, principally vineyards. In many places, areas of this soil are step terraced or leveled before grapes or trees are planted. The shallowness of the soil material remaining after such operations can be partly offset by ripping and breaking up some of the compact parent sediments. It is generally beneficial to fertilize the soil with nitrogen and phosphorus and to encourage accumulation of organic matter in the freshly exposed surface layer. The coarser texture and the slightly lower available water holding capacity make it necessary to irrigate this soil somewhat more frequently than Pollasky fine sandy loams. Some areas of Pollasky sandy loam, 2 to 9 percent slopes, are used for grazing or are idle. Capability unit IIIe-3 (17); range site 6; natural land type E1; Storie index rating 57.

Pollasky sandy loam, 15 to 30 percent slopes (PmD).—This moderately steep soil has a profile that is similar to that of Pollasky sandy loam, 9 to 15 percent slopes. It is on terrace breaks in hilly areas near the San Joaquin River between Herndon and Friant. Runoff is medium to rapid, and the hazard of erosion is moderate to high.

A small area of a similar soil that is steep was included with this soil in mapping.

Most areas of Pollasky sandy loam, 15 to 30 percent slopes, are used for grazing or for dryfarmed barley. Some areas are idle. Forage growth is improved if the soil is fertilized with nitrogen, phosphorus, and sulfur. Care should be taken to avoid overgrazing. Capability unit VIe-1 (17, 18); range site 6; natural land type E1; Storie index rating 48.

Pollasky-Montpellier complex, 9 to 15 percent slopes (PoC).—This mapping unit consists of Pollasky and Montpellier soils that are so closely intermingled that it is impractical to separate them at the scale used in mapping. Although the acreage of each soil varies from one area to another, the total acreage of the two soils is nearly equal. The profiles of these soils are similar to those described as typical for the respective series. The surface layer of the Montpellier soil is coarse sandy loam, and that of the Pollasky soil is generally sandy loam but in places is coarse sandy loam.

This complex is located on degraded terraces south of Little Dry Creek and north of Copper Avenue. Runoff is medium, and the erosion hazard is moderate.

Included with this complex in mapping were small areas of Cometa sandy loam and some areas of a soil that is similar to the Pollasky soil but has a subsoil with a slight accumulation of clay. Small areas of San Joaquin sandy loam occupy the crests of some knolls and ridges.

This complex is used mainly for grazing and dryfarmed barley. In addition, some pasture irrigated by sprinklers has been developed, and a turkey farm has been established. Growth of forage is fair if the soils have adequate moisture; it can be improved by applying fertilizers to supply needed nitrogen, phosphorus, and sulfur. Capability unit IVe-3 (17); range site 6; natural land types E1 and E3; Storie index rating 52.

Pollasky-Montpellier complex, 15 to 30 percent slopes (PoD).—This complex consists of hilly Pollasky sandy loam and Montpellier coarse sandy loam that are so intermingled that it is not practical to separate them at the scale used in mapping. The total acreage of the two soils is nearly equal.

This complex is in several large areas on the terraces of the San Joaquin River, extending from the town of Friant south to the vicinity of Copper Avenue.

Runoff is medium to rapid, and the hazard of erosion is moderate to high. Some rills and gullies have formed in fallow areas, mainly in areas of the Montpellier soil.

Grazing and dryfarmed barley are the principal uses of the soils in this complex. Management is similar to that of Pollasky-Montpellier complex, 9 to 15 percent slopes. Capability unit VIe-3 (17); range site 6; natural land types E1 and E3; Storie index rating 47.

Pollasky-Rocklin sandy loams, 3 to 15 percent slopes (PpC).—The undulating to rolling soils of this complex occupy degraded areas of the low terraces of the San Joaquin River. The Pollasky soil is dominant; it is mainly in the steeper areas. Its profile is similar to that described as typical for the Pollasky series. The Rocklin soil comprises about 20 to 30 percent of the complex and is mainly on the gently sloping areas of this unit. Its profile is similar to that described as typical for the Rocklin series, but the depth to hardpan is only about 12 to 24 inches. This complex is north of Pinedale and in the vicinity of Fort Washington golf course.

Runoff is medium; erosion hazard is moderate. The available water holding capacity is very low or low.

Small areas of Hanford and Greenfield soils were included with this complex in mapping. These soils occupy the narrow bottoms of drainage swales.

This complex is used mainly for dryfarmed barley and for grazing. Production of barley is lower on the Rocklin soil than on the Pollasky soil because of the somewhat lower available moisture holding capacity. The response of forage growth to fertilization is similar to that for Pollasky sandy loam, 9 to 15 percent slopes. Some of the fairways and greens of the Fort Washington golf course have been developed on a part of this complex. Some areas of this complex have also been used for country homes. Capability unit IVe-3 (17); range site 6; natural land types E1 and E5; Storie index rating 49.

Pond Series

The Pond series consists of saline-alkali affected soils that formed under somewhat poorly drained conditions in the basin-rim zone. The soils have a clay loam subsoil that is readily distinguished from the surface layer and underlying parent material. The parent material consists of moderately coarse to moderately fine textured granitic alluvium formerly deposited by floodwaters from the San Joaquin or Kings Rivers. The soils are nearly level, but they have a rough, low, hummocky microrelief, which is the result of infrequent sheetwash flooding and soil blowing. Excess salts and alkali have caused scattered areas to be bare of vegetation and therefore open to wind scouring.

The Pond soils lie mainly west and northwest of Kerman and in an irregular band from the general vicinity of Raisin City southeastward toward Riverdale and Laton. The soils are at elevations of 165 to 230 feet. The average annual precipitation is 8 inches, the average annual temperature is about 63° F., and the average growing season ranges from 225 to 275 days. The natural vegetation consists of some annual grasses and forbs and many saline-alkali tolerant plants. The grasses and forbs are generally stunted in growth.

In a typical profile, the Pond soils have a light-gray, calcareous, moderately alkaline fine sandy loam surface layer about 3 inches thick. This layer overlies a layer of white fine sandy loam that is about 2 inches thick and is moderately calcareous and strongly alkaline. The subsoil, about 15 inches thick, is moderately calcareous and very strongly alkaline. In the upper part it is light-gray sandy loam; in the middle part, light brownish-gray sandy clay loam; and in the lower part, light brownish gray to grayish-brown clay loam. Underlying the subsoil is light yellowish-brown sandy loam and light-gray sand.

Under natural conditions, these soils are used for alkali pasture. If they are irrigated and reclaimed, they are used for cotton, alfalfa, and irrigated pasture. Water for irrigation is obtained from wells. It is generally of good quality.

Representative profile in native alkali pasture consisting of annual grasses and alkali tolerant plants, in a nearly level area having low, hummocky microrelief, at an elevation of about 188 feet (about 6 miles, airline, SE. of the town of San Joaquin, 1.1 miles along McMullin Grade, NE. of the Fresno Slough bypass causeway, and 175 feet W. of the grade in the SE¼SE¼SE¼ sec. 35 T., 15 S., R. 17 E.)

A1—0 to 3 inches, light-gray (2.5Y 7/2) fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; massive; hard when dry, friable when moist, nonsticky and nonplastic when wet, plentiful fine roots, few to very few very fine tubular pores, abundant microsize interstitial pores; slightly calcareous, moderately alkaline (pH 8.0), abrupt, wavy lower boundary.

A2ca—3 to 5 inches, white (2.5Y 8/1) fine sandy loam, grayish brown (2.5Y 5/2) when moist; massive (single grain); slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet, plentiful fine roots; abundant microsize interstitial pores; moderately calcareous; strongly alkaline (pH 9.0); very abrupt, wavy lower boundary.

B1ca—5 to 8 inches, light-gray (2.5Y 7/2) sandy loam, grayish brown (2.5Y 5/2) when moist; massive to very weak, coarse, angular blocky structure; ped faces have coatings that are light brownish gray (2.5Y 6/2) when dry; very hard when dry, friable when moist, slightly sticky and nonplastic when wet; very few fine roots; common very fine tubular pores and common microsize interstitial pores, common clay films in pores and much clay bridging and grain coatings, moderately calcareous, very strongly alkaline (pH 9.9), abrupt, wavy lower boundary.

B21tca—8 to 17 inches, light brownish gray (2.5Y 6/2) sandy clay loam, dark grayish brown (2.5Y 4/2) when moist, weak, coarse, angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet, occasional fine roots, common very fine tubular pores; many, moderately thick clay films on ped faces and in pores, clay films are grayish brown (2.5Y 5/2) when dry and very dark grayish brown (2.5Y 3/2) when moist, moderately calcareous, carbonates largely in the form of soft nodules and splotches, very strongly alkaline (pH 10.2), very abrupt, wavy lower boundary.

IIB22tca—17 to 20 inches, variably light brownish gray to grayish-brown (2.5Y 6/2, [illegible]) clay loam, olive gray (5Y [illegible]) when moist; abundant, fine, distinct mottles of yellowish brown (10YR 5/6 when dry, 10YR 5/8 when moist); weak, medium blocky structure that shows some remnants of an originally platy structure; very hard when dry, friable when moist, sticky and plastic when wet, common microsize tubular pores; few thin clay films on ped faces; moderately calcareous, carbonates mainly in the form of nodules; very strongly alkaline (pH 10.4); very abrupt, wavy lower boundary.

IIIC1—20 to 25 inches, light yellowish-brown (2.5Y 6/3) sandy loam, olive (5Y 5/3) when moist, massive,

hard when dry, very friable when moist, slightly sticky and nonplastic when wet; common fine tubular pores and many microsize interstitial pores, common clay bridging and grain coatings; slightly calcareous with disseminated carbonates; very strongly alkaline (pH 10.4); diffuse, smooth lower boundary.

IVC2 34 inches +, light gray (2.5Y 7/2) sand, grayish brown (2.5Y 5/2) when moist; massive, slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; many microsize and very fine interstitial pores; noncalcareous; very strongly alkaline (pH 10.3).

The A1 horizon, or Ap horizon in cultivated areas, ranges from light gray to light brownish gray. Its hue is 10YR or 2.5Y, value 6 or 7, and chroma is 1 or 2. When this layer is moist, it is grayish brown or dark grayish brown and has a moist color value of 4 or 5 and chroma of 2. There is no A2 horizon in cultivated areas. The A horizon is generally massive, but in some places it has weak platy structure. The dry consistence is slightly hard to hard. The reaction is moderately alkaline to strongly alkaline. Texture of the A horizon is sandy loam, fine sandy loam, or loam.

The B2t horizon ranges from grayish brown to light grayish brown (10YR 5/2, 6/2; 2.5Y 5/2, 6/2). When this layer is moist, it ranges from grayish brown or dark grayish brown to light olive brown (hue of 10YR 4/2, 5/2; 2.5Y 4/2, 4/3, 5/2, 5/3; 5Y 4/2, 4/3, 5/2, 5/3) and has some variable combinations of these colors, which cause mottling. Texture is clay loam, sandy clay loam, and silty clay loam. The structure is weak to strong, medium to coarse, angular blocky. The reaction is strongly alkaline to very strongly alkaline.

The C horizon is light yellowish-brown to light gray, stratified, generally permeable alluvium. Its texture is sandy loam, fine sandy loam, and sand. The C horizon is calcareous in some places and not in others. Typically, however, it is strongly alkaline to very strongly alkaline in uncultivated areas.

Pond fine sandy loam (0 to 2 percent slopes) (Pt).—This nearly level soil is scattered in areas of various sizes along the basin rim from Whites Bridge to Riverdale. It has a profile very similar to that described as typical for the series. The subsoil and underlying material of this soil are nearly everywhere strongly alkaline or very strongly alkaline and at least slightly saline from the accumulation of neutral and basic salts. In more than half of the acreage, the surface layer is similarly affected to the extent that normal plant growth is severely depressed. In the rest, the surface layer is essentially free of excess salts and alkali.

Drainage in this soil has been improved. Extensive pumping for irrigation water has lowered the water table to such an extent that it no longer influences the soil. Permeability is moderately slow. Runoff on the natural surface, however, is very slow because of the uneven microrelief. Some of the surface water is ponded in the small playas. The hazard of erosion from water is none to slight, but there is a slight hazard of erosion from wind. The available water holding capacity is moderate if the soil is reclaimed.

Included with this soil was a small area, northeast of Tranquillity, that had been reclaimed at the time of mapping and was essentially saline-alkali free. Also included were small areas of saline-alkali soils of Fresno, Traver, and Chino series. Many playas smaller than one-half acre were included.

Natural areas of this soil are idle or are used for alkali pasture. They provide habitats for many forms of small wildlife that inhabit the alkali plains of the Central Valley.

The soil must be reclaimed before irrigated crops can be successfully grown. For a discussion of methods used in this survey area, see the section "Saline and Saline-Alkali Soils." The permeability of the subsoil slows reclamation of this soil. For this reason, deep ripping and mixing the subsoil with the surface layer and parts of the underlying material, and leveling are generally used to prepare the land for efficient irrigation. Generally, several seasons are required to reclaim this soil.

Irrigated barley is normally grown as a first crop, and this is followed by alfalfa or irrigated pasture. Cotton generally is planted after these crops or is substituted for them. Reclaimed areas are suited to corn, grain sorghum, and sugar beets. Nitrogen and phosphorus fertilizers need to be added. Capability unit IIIa-6 (17); range site not assigned; natural land type B2-2a; Storie index rating 16.

Pond fine sandy loam, moderately deep (0 to 2 percent slopes) (Pu).—The profile of this soil is similar to that described as typical for the series, but it overlies a compact silty substratum at a depth of 2 to 4 feet. In places, the lower part of the subsoil is directly over the substratum, but it is commonly over a layer of somewhat coarser textured material. The substratum ranges from a few inches to a few feet in thickness and is weakly cemented with lime in places. In places it is stratified with thin layers of moderately coarse textured or coarse textured material similar to that which underlies the substratum. Where it is unbroken, the substratum impedes internal drainage and hinders deep leaching and reclamation of this saline-alkali affected soil.

This soil is in areas of various sizes in the basin rim zone from the vicinity of Whites Bridge to that of Burrel. Included was a small area of completely reclaimed soil south of Kerman.

The use and management of Pond fine sandy loam, moderately deep, are similar to those of Pond fine sandy loam. Deep chiseling or ripping is needed to break up the substratum and to insure better internal drainage and hasten the rate of reclamation. Capability unit IIIa-6 (17); range site not assigned; natural land type B2-2a; Storie index rating 11.

Pond loam (0 to 2 percent slopes) (Pv).—This nearly level soil has a profile similar to that of Pond fine sandy loam but the surface layer is a loam. It is in small areas that are widely distributed throughout the basin rim zone. Its subsoil is clay loam or silty clay loam. Some areas having a surface layer of clay loam are included.

The use and management of Pond loam are similar to those of Pond fine sandy loam. The finer textured surface layer provides somewhat greater available moisture for forage plants if it is not saline-alkali affected. Under cultivation, the surface layer is somewhat more cloddy than that of Pond fine sandy loam, and good seedbed preparation is more difficult. Capabil-

ity unit IIs-6 (17); range site not assigned; natural land type B2-2a; Storie index rating 16.

Pond loam, moderately deep (Pw).—This saline-alkali soil is mainly between McMullin Grade and Whites Bridge in the basin rim zone. It has a profile similar to that of Pond fine sandy loam but the surface layer is loam. It overlies a compact silty substratum at a depth of 2 to 4 feet. The substratum ranges from a few inches to a few feet in thickness and is weakly lime cemented in places. There are a greater number of small playas included in areas of this soil than in areas of Pond soils having a moderately coarse textured surface layer.

The general use and management of this soil are similar to those of Pond fine sandy loam and Pond loam. Deep ripping of the substratum is needed before reclamation attempts are made in order to improve the internal drainage and speed the leaching needed to remove the excess salts and alkali. Capability unit IIIs-6 (17); range site not assigned; natural land type B2-2a; Storie index rating 11.

Pond sandy loam (0 to 2 percent slopes) (Pr).—The profile of this soil is similar to that of Pond fine sandy loam, but it has a sandy loam surface layer and generally a sandy clay loam subsoil. Under natural conditions, the bare spots on the surface tend to be somewhat more susceptible to soil blowing. If the soil is reclaimed, it tends to be slightly more droughty than Pond fine sandy loam.

Pond sandy loam is widely distributed along most of the basin rim zone from the vicinity of Laton to that of Whites Bridge. Its use and management are similar to those of Pond fine sandy loam. Capability unit IIs-6 (17); range site not assigned; natural land type B2-2a; Storie index rating 15.

Pond sandy loam, moderately deep (Ps).—This soil has a sandy loam surface layer and a subsoil of sandy clay loam that overlies a compact, silty substratum at a depth of 2 to 4 feet. It is otherwise similar to Pond fine sandy loam. Not so much of the surface layer of this soil is saline-alkali affected as that of Pond fine sandy loam. This soil is also somewhat more susceptible to soil blowing.

This soil is distributed in areas of various sizes from the vicinity of Burrel to the area directly northeast from Tranquillity across the basin rim zone. Included in mapping were small, completely reclaimed areas that are south of Kerman.

The use and management of Pond sandy loam, moderately deep, are similar to those of Pond fine sandy loam. Deep ripping of the substratum is helpful in reclaiming this soil. Capability unit IIIs-6 (17); range site not assigned; natural land type B2-2a; Storie index rating 11.

Porterville Series

The Porterville series consists of deep, well-drained, clay soils that formed in colluvium occupying the foot slopes and skirting many hills of basic igneous rocks. The colluvium consists of clayey soil material that in times past, moved slowly downslope when it was wet. The material was derived from soils weathered in place from the gabbro and diorite rocks of the hills. The Porterville soils have smooth, somewhat concave slopes or are nearly level. Slopes range from 0 to 30 percent.

These soils are along the lower edge of the foothills from Round Mountain southeastward to Orange Cove. Some areas are associated with foothill outliers such as Smith and Campbell Mountains. The soils are at elevations of 300 to 500 feet. The average annual precipitation ranges from about 13 to 15 inches. The average annual temperature is about 62° F., and the average growing season is from 250 to 275 days. Most of the acreage of the soils is in the thermal belt, or zone of minimum frost hazard, along the edge of the foothills. The natural vegetation consists of annual grasses and forbs. Many of the forbs are clovers.

In a typical profile, the surface layer is dark reddish-brown, neutral clay about 8 inches thick. Between depths of 8 to 27 inches is dark reddish-gray clay that is mildly alkaline. This layer overlies dark-brown clay that is moderately alkaline and slowly to very slowly permeable when moist. Deep, wide cracks commonly form when the soil is dry. Smooth, shiny block faces marked with many, fine, parallel grooves are typical in the deeper parts of the soil. These come from the shrinking, swelling, and slow churning of the soil under alternate wetting and drying.

Under natural conditions, these soils are used for pasture. Under irrigation they are used for truck crops, cotton, and citrus. Water for irrigation is obtained mainly from local wells. Some of these wells produce a small amount of water and therefore require reservoirs to accumulate enough water for efficient irrigation. In some places, water is available from irrigation district canals.

Representative profile in native pasture under a dense cover of annual grasses and forbs on a very gentle, southeast-facing slope of about 2 percent, at an elevation of 480 feet (about 3 miles, airline, NNW of Navelencia; 100 feet NW. of the intersection of State Highway No. 180 and the north-south center line of sec. 18, marked by a field fence S. of the highway, in the SE¼NE¼NW¼ of sec. 18, T. 14 S., R. 24 E.):

A11—0 to 8 inches, dark reddish-brown (5YR 3/2) clay, very slightly darker when moist; strong, fine to coarse, angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; abundant fine grass roots; structural units swell visibly upon wetting; neutral (pH 7.0); abrupt, wavy lower boundary.

A12—8 to 27 inches, dark reddish-gray (5YR 4/2) clay, dark reddish brown (5YR 3/2) when moist; structure similar to that in A11 horizon; common horizontal and nearly vertical slickensides on pressure faces; very hard when dry, firm when moist, sticky and plastic when wet; abundant fine grass roots; few fine tubular pores; medium to coarse open vertical cracks when dry; slightly and intermittently calcareous with disseminated lime; mildly alkaline (pH 7.6); clear, irregular lower boundary.

C1—27 to 40 inches, dark-brown (7.5YR 3/2) clay, dark reddish brown (5YR 3/3) when moist; strong, medium to coarse, angular blocky structure; very hard

when dry, firm to very firm when moist, sticky and very plastic when wet; very few fine roots; few fine tubular pores; medium to coarse open vertical cracks when dry; many slickensides at angles that average about 38°; slightly calcareous from disseminated lime and a few fine to medium hard lime nodules; moderately alkaline (pH 8.0); clear, irregular lower boundary.

C2—40 to 71 inches +, dark brown (7.5YR 3/4) clay, dark reddish brown (5YR 3/3) when moist; strong, coarse angular blocky structure; very hard when dry, very firm when moist, sticky and very plastic when wet; occasional clusters of fine roots follow some deep vertical cracks; very few fine tubular pores; many slickensides at angles that range from about 30° to 38°; slightly calcareous from disseminated lime and common, fine to medium, hard lime nodules; moderately alkaline (pH 8.0).

The A horizon is dark brown to dark reddish brown or dark reddish gray. The hue is 7.5YR or 5YR, the value 3 or 4, and the chroma 2 or 3. When the A horizon is moist, there is generally little change in color, but in places the hue changes to 2.5YR. The structure is somewhat variable and depends upon the degree of dryness of the soil material. It ranges from granular to blocky, from fine to very coarse, and from weak to strong. When fully dried, the A horizon typically has a strong, fine, blocky or strong granular structure and large cracks that penetrate deeply into the profile. The reaction is neutral to mildly alkaline. The lower part of the A horizon is calcareous in some places. This horizon is typically clay, but in places it contains varying amounts of gravel and cobblestones.

The C horizon is similar to the A horizon in range of color but may include hues of [illegible]. The structure is blocky, and slickensides are well developed. The slope of slickensided faces tends to decrease with depth. The reaction is mildly alkaline to moderately alkaline. Lime is commonly present and appears in disseminated form, as soft splotches, or as common hard nodules. In places little or no lime has accumulated. In some places the Porterville soils contain cobblestones in the C horizon.

In places an unconsolidated substratum that ranges from coarse alluvium to weathered rock lies below a depth of about 60 inches.

Porterville clay, 0 to 3 percent slopes (PxA).—This soil has the profile that is typical for the series and occupies colluvial fans and foot slopes about and near Round Mountain, Campbell Mountain, and Smith Mountain. Permeability is slow. Runoff is very slow at the beginning of the rainy season. Nearly all of the water runs down the deep cracks or is absorbed by the soil. After wetting, the cracks swell shut and runoff is slow. The hazard of erosion is none to slight. The available water holding capacity is high.

Included with this soil in mapping south of Tivy Valley was a very small area of shallow, dark-gray, calcareous clay loam that overlies white, limy, soft sandstone. South of Round Mountain, west of Smith Mountain, and in areas somewhat less well drained near Jesse Morrow and Campbell Mountains, there are included areas of a soil similar to the Porterville soils, but it is dark grayish brown or dark gray and calcareous throughout. In places this soil has a clay loam surface layer. On the toe slopes of Granite Hill and Jesse Morrow Mountain, there are small areas of similar soils that have a texture of cobbly clay. Included in places at the base of the old, high alluvial terrace northeast of Centerville and south of Tivy Valley, there are areas of similar soils having a texture of gravelly clay. The volume of coarse fragments comprise no more than about 20 percent of these soils. The location of these soils is shown on the maps by symbols for cobblestones and gravel.

Under natural conditions, Porterville clay, 0 to 3 percent slopes, is generally well suited for grazing. A good growth of forage is produced during years when the rainfall is normal or better. The forage responds well to nitrogen fertilizers, and the clovers can be stimulated by use of sulfur.

Under irrigation, the soil is used for irrigated pasture, cotton, citrus, olives, figs, and some truck crops, mainly tomatoes. Some grapes also are grown. The citrus and tomatoes are grown on this soil because the soil is within the thermal belt where there is less hazard from frost. Olives and figs do well but are limited in acreage. Grapes are more difficult to manage because of the clayey texture and high available water holding capacity of the soil. The scheduling of irrigation, spraying, and weed control generally must be done at a different time than on the adjacent lighter textured soils, which dry out more quickly and can support the necessary farm machinery. This soil should be cultivated when it is neither too dry nor too wet. In comparison to other clay soils, however, it is easier to obtain good tilth in this soil because of the strong tendency of the soil to granulate upon drying. Consequently, there is less tendency for a plowpan or traffic pan to form. Capability unit IIs–5 (17); range site 3; natural land type C4; Storie index rating 54.

Porterville clay, 3 to 15 percent slopes (PxC).—This gently sloping to strongly sloping soil is on colluvial fans. It has a profile similar to that of Porterville clay, 0 to 3 percent slopes. It is in areas of varying size located on the foot slopes of Smith Mountain, Granite Hill, Campbell Mountain, Jesse Morrow Mountain, Tivy Mountain, Kirkman Hill, and Round Mountain, and at the base of hills in the vicinity of Holland Creek. Most of the areas have slopes of 3 to 9 percent although the slopes range to 15 percent. Runoff is medium after the soil has been wet and the deep cracks have swollen shut. The erosion hazard is slight.

Minor areas of similar soils that are dark grayish brown and calcareous throughout are included. They are on the west footslope of Smith Mountain and in a small valley east of Round Mountain.

The use and management of Porterville clay, 3 to 15 percent slopes, are similar to those of Porterville clay, 0 to 3 percent slopes. Under irrigation, however, oranges are the principal crop grown. The position of this soil provides better air drainage than that in more gently sloping areas. Of the developed areas used for citrus, this soil probably has the least frost hazard. Irrigation is mainly by low-set sprinklers. Capability unit IIIe–5 (17); range site 3; natural land type C4; Storie index rating 49.

Porterville cobbly clay, 3 to 15 percent slopes (PyC).—The profile of this soil is similar to that of Porterville clay, 0 to 3 percent slopes, but 20 to 30 percent of the soil, by volume, consists of subangular to subrounded cobblestones. It is gently sloping to moderately sloping. The soil is on colluvial fans forming foot slopes around parts of the high, alluvial terraces

north of Centerville and southwest of Tivy Valley, Tivy Mountain, Jesse Morrow Mountain, Campbell Mountain, Granite Hill, and some hills east of Round Mountain. Areas of this soil containing subrounded cobblestones are located on the side slopes of the high alluvial terraces, and the rest of the areas contain subangular cobblestones. Most areas of this soil have slopes of 3 to 9 percent, but a few range from 9 to 15 percent. Runoff is medium after the soil has been wet and the surface cracks have swollen shut. The hazard of erosion is slight.

Included in this unit is a minor area of shallow, dark gray, calcareous clay loam underlain by white, limy, softly consolidated sandstone. This included soil is south of Tivy Valley near the base of Jesse Morrow Mountain.

Tillage of Porterville cobbly clay, 3 to 15 percent slopes, is difficult. Wear and damage to light or medium equipment for cultivation is moderate to severe. For this reason, and because too little water is available for irrigation, this soil is used only for range or pasture. Its management for grazing is similar to that of Porterville clay, 0 to 3 percent slopes. Capability unit IIIe-5 (17); range site 3; natural land type C8; Storie index rating 32.

Porterville very cobbly clay, 0 to 30 percent slopes (PzD).—The profile of this soil is similar to that described as typical for the series, but it contains more than 50 percent, by volume, of subrounded or subangular cobblestones in the surface layer. The underlying material is about 30 percent cobblestones, by volume. Most of the acreage has slopes of more than 3 percent. This soil is on the east end of the high alluvial terrace north of Centerville, where the cobblestones are subrounded. It is also located on the south foot slopes of Jesse Morrow Mountain and parts of the foot slopes of Campbell Mountain.

Runoff is medium after the soil has been wet and the surface cracks have closed. The hazard of erosion is none to slight. The cobbly surface affords some protection against soil wash. The available water holding capacity is moderate.

Tillage is impractical or impossible, even with heavy equipment. All of the acreage of this soil is used for range. Little forage is produced because of the cobblestones in the surface layer. Fertilization of this soil is not practical. Capability unit VIIs-7 (17, 18); range site 3; natural land type C17; Storie index rating 15.

Positas Series

The Positas series consists of well-drained to somewhat excessively drained soils that have a clay subsoil. These soils formed in gravelly or cobbly very old alluvial material of mixed origin. These soils are undulating to steep and hilly and are on degraded, high alluvial terraces in the vicinity of Friant and Millerton Lake, and south of Tivy Valley. Slopes are 3 to 45 percent.

The soils are at elevations of 450 to 1,400 feet. The average annual precipitation ranges from 14 to 15 inches, the average annual temperature from 61° to 62° F., and the average growing season from 240 to 275 days. The natural vegetation consists of annual grasses and forbs.

In a typical profile, the surface layer is brown, strongly acid gravelly loam about 4 inches thick. This layer overlies a subsoil of brown to dark-brown gravelly sandy clay loam, reddish-brown clay, and yellowish-red gravelly sandy clay loam. The subsoil is medium acid. At a depth of about 36 inches, it grades into variably gravelly and compacted sandy material several to many feet thick.

The Positas soils are used for pasture or range. There are no local, dependable sources of water for livestock except for small drainageways that carry runoff water intermittently during the rainy season. Some wells have been dug in these soils, but they have not been successful.

Representative profile in a range area of annual grasses, on a northerly slope of 35 percent cut into a high lying, very old river terrace, at an elevation of about 1,200 feet (about 5 miles, airline, E. of the town of Friant, in the SW¼SE¼NE¼ of sec. 12, T. 11 S., R. 21 E.):

A1—0 to 4 inches, brown (10YR 5/3) gravelly loam, dark brown (7.5YR 3/2) when moist; massive; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; plentiful very fine roots; many fine tubular pores; rounded cobblestones scattered on the surface; strongly acid (pH 6.5); abrupt, wavy lower boundary.

B1—4 to 8 inches, brown to dark brown (10YR 4/3) gravelly sandy clay loam, dark brown (7.5YR 3/2) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist, sticky and slightly plastic when wet; few very fine roots; few fine tubular pores; many thin clay films on ped faces; medium acid (pH 5.8); abrupt, wavy lower boundary.

B21—8 to 24 inches, reddish brown (5YR 4/4) clay, dark red (2.5YR 3/6) when moist; strong, coarse, angular blocky structure; very hard when dry, firm when moist, very sticky and plastic when wet; continuous, thick clay films on ped faces; a few pebbles and cobblestones; medium acid (pH 6.0); abrupt, wavy lower boundary.

B3—24 to 36 inches, yellowish red (5YR 5/6) gravelly sandy clay loam, reddish brown (5YR 4/4) when moist; massive; very hard when dry, firm when moist, very sticky and plastic when wet; medium acid (pH 6.0); abrupt, wavy lower boundary.

C—36 to 60 inches +, compacted gravelly to cobbly sandy loam, similar in color to B3 horizon; massive; very hard when dry, friable when moist, nonsticky and nonplastic when wet; medium acid (pH 6.0); several feet thick, overlies unrelated, weathered granitic rock.

The A horizon is generally brown or dark brown but varies in shade (10YR 5/3, 4/3; 7.5YR 5/2, 5/4, 4/4, 4/2, 3/4, 3/2). When moist, it is dark brown (7.5YR 3/2). The texture ranges from gravelly loam to gravelly or cobbly clay loam. The amount of cobblestones on the surface varies from place to place. The A horizon is generally less than about 15 percent, by volume. The A horizon is typically massive and slightly hard to very hard when dry. The reaction ranges from neutral to strongly acid.

The B2t horizon is normally reddish brown, but it is yellowish red or dark brown in places (5YR 4/3, 4/4, 5/3, 5/4, 4/6; 7.5YR 4/2). When this layer is moist, the color ranges from reddish brown, dark reddish brown, or yellowish red to red or dark red (5YR 4/4, 3/4, 3/3, 4/6; 2.5YR 3/6, 4/6). The structure is generally strong, coarse, subangular or angular blocky. The reaction ranges from medium acid to

mildly alkaline. The amount of cobblestones varies but is generally less than that of the A horizon. The texture is clay, gravelly clay, or cobbly clay.

The C horizon is variable in the compaction of the sandy loam in which pebbles and cobblestones are imbedded. Some areas consist of uncompacted or only slightly compacted material, and others are made up of compacted material that hardens upon exposure, particularly in the first few inches below the B horizon. This compacted material has the appearance of a hardpan, but is not irreversibly cemented. Color of the C horizon ranges from very pale brown to reddish yellow or yellowish red. Reaction ranges from medium acid to mildly alkaline.

Positas gravelly loam, 30 to 45 percent slopes (PzaE).—This soil occupies degraded remnants of old, high lying alluvial terraces that are scattered in the granitic uplands east of Friant and along the north side of Little Dry Creek, southeast of Friant. It has the profile described as typical for the series. The soil is steep and hilly, and the surface has many low hummocks. Some areas of the soil near seep spots around Little Dry Creek contain some yellowish mottling in the subsoil.

The soil is very slowly permeable. Runoff is rapid, and the hazard of erosion is high. The available water holding capacity is low to very low; few roots penetrate the dense subsoil.

This soil is used only for range. If the soil contains adequate moisture, the forage yield can be increased. The palatability of the forage can be improved by adding nitrogen and phosphorus fertilizers to the soil. The steep slopes make application of fertilizer to the surface difficult. Placing salt blocks upslope or away from water sources helps to distribute grazing animals so that the available forage is grazed more evenly. Capability unit VIe-3 (17); range site 8; natural land type E12; Storie index rating 11.

Positas gravelly loam, 3 to 9 percent slopes (PzaB).—This undulating soil occupies terrace remnants in the lower foothills southeast of Friant, and is also on high terraces northwest of Centerville and south of Tivy Valley. It has a profile that is similar to that of Positas gravelly loam, 30 to 45 percent slopes. Runoff is medium, and the hazard of erosion is slight to moderate. The soil is well drained.

The surface layer ranges from gravelly loam to cobbly clay loam. The cobbly areas are indicated on the map by symbols for cobblestones. A small area of a similar soil that has a clay loam surface layer has also been included.

Positas gravelly loam, 3 to 9 percent slopes, is used principally for range or pasture. Where irrigation water has been made available, some areas have been planted to olives and oranges. The only successful plantings, however, are on the included areas of clay loam. Forage growth is fair but, if moisture is adequate, can be improved through fertilizing with nitrogen and phosphorus. Capability unit IVe-3 (17); range site 8; natural land type E4; Storie index rating 28.

Positas gravelly loam, 9 to 30 percent slopes (PzaD).—This well-drained to somewhat excessively drained soil is on hilly remnants of degraded high terraces southeast of Friant and in the vicinity of Tivy Valley. It has a profile similar to that of Positas gravelly loam, 30 to 45 percent slopes. Near Friant, the soil has a low, hummocky microrelief. Runoff is medium to rapid, and the hazard of erosion is moderate to high.

The surface layer ranges from gravelly loam to gravelly or cobbly clay loam. The cobbly areas are indicated by symbols on the soil map. A small area of a similar soil that has a gravelly sandy loam surface layer has also been included.

Areas of this soil are used for range or pasture. An attempt was made to plant citrus on some areas south of Tivy Valley, but the plantings were not successful. Forage growth can be improved, if moisture is adequate, through fertilizing with nitrogen and phosphorus. Capability unit VIe-3 (17); range site 8; natural land type E4; Storie index rating 21.

Ramona Series

The Ramona series consists of well-drained soils that formed in moderately coarse textured old granitic alluvium. These soils have a dominantly sandy clay loam subsoil that tends to slow, but not seriously impede, penetration by roots and water. The soils are smooth and nearly level and occupy low alluvial terraces. They comprise a large part of the low alluvial terraces from Friant to Orange Cove. Areas of these soils are also located in some lower foothill valleys.

On the terraces, the soils are at elevations of 250 to 500 feet. In the foothill valleys, they range up to about 1,500 feet. The average annual precipitation ranges from 9 to 16 inches on the terraces and up to about 20 inches in the lower foothills. The average annual temperature is 60° to 62° F., and the average growing season ranges from 225 to 275 days. In areas along the edge of the foothills, the growing season is longer than in other areas. The natural vegetation consists almost entirely of annual grasses and forbs. Some oak trees grow in the soils in the foothills.

In a typical profile, the surface layer is brown, neutral to slightly acid sandy loam about 12 inches thick. The subsoil is brown sandy loam and light-brown and light reddish-brown sandy clay loam about 26 inches thick. The subsoil grades into a thick layer of light yellowish brown coarse sandy loam parent alluvium.

In areas that are not irrigated, these soils are used for grazing or for dryfarmed barley. Under irrigation, they are used for a wide variety of field, forage, and fruit crops. Irrigation water is obtained from irrigation district canals and from local wells. The water table stands at a depth ranging from about 30 to 100 feet.

Representative profile in a nearly level undisturbed area of annual grasses and forbs on an extensive low terrace of the San Joaquin River, at an elevation of 365 feet (about 3½ miles, airline, NW. of Clovis, 150 feet W., 65 feet S. of the SW. corner of Shepherd and Willow Avenues, in the NE¼NE¼NE¼ of sec. 25, T. 12 S., R. 21 E.):

A11—0 to 5 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) when moist; moderate, medium and fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and non-

plastic when wet; abundant fine roots, many microsize to fine interstitial pores; slightly acid (pH [illegible]); abrupt, wavy boundary.

A12—5 to 12 inches, brown (10YR 5/3) sandy loam, dark brown (10YR [illegible]/3) when moist; massive; hard when dry, friable when moist, slightly sticky and nonplastic when wet; few fine roots, common fine and very fine tubular pores, many microsize interstitial pores; neutral (pH 6.6); clear, wavy lower boundary.

Bt—12 to 24 inches, brown (7.5YR 5/4) sandy loam, dark brown (7.5YR 4/4) when moist. When dry the soil has a speckled appearance, the matrix is brown as described and shows many very fine spots of pale brown (10YR 6/3); very weak, coarse, subangular blocky structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; very few fine roots, common fine and very fine tubular pores, many microsize interstitial pores, few insect burrows; few thin clay films in tubular pores; neutral (pH 7.0); clear, wavy lower boundary.

B2t—24 to 38 inches, light-brown and light reddish-brown (7.5YR, 5YR 6/4) sandy clay loam, reddish brown (5YR 4/4) when moist; weak, coarse, angular blocky structure; very hard when dry, friable when moist, sticky and slightly plastic when wet; few very fine tubular pores, common microsize interstitial pores; common thin to moderately thick clay films in pores and on ped faces; clay films are reddish brown (5YR 4/4) when dry, dark reddish brown (2.5YR 3/4) when moist; neutral (pH 7.0), tongues deeply into C horizon; abrupt, irregular lower boundary.

C—38 to 72 inches +, light yellowish-brown (10YR 6/4) coarse sandy loam, dark brown (7.5YR 4/4) when moist; massive; hard when dry, friable when moist, slightly sticky and nonplastic when wet; many microsize interstitial pores, thin tongues of material from B2t horizon and clay films on joint planes penetrate to about 70 inches; neutral (pH 7.1).

The A horizon is typically brown, but it varies in shade (10YR 5/3, 7.5YR 5/2, 5/4). In places it is dark brown (10YR 4/3, 7.5YR 4/2, 4/4). When this layer is moist it is generally dark brown (10YR 3/3; 7.5YR 3/2). In cultivated areas the A horizon is massive or cloddy and hard when dry. In uncultivated areas the A11 horizon is generally thin and has a weak to moderate granular structure. It is underlain by a massive subsurface A12 horizon that is typically hard when dry. The reaction of the A horizon is slightly acid to neutral. The texture ranges from sandy loam to loam.

The B2t horizon ranges from brown to reddish brown but is commonly light reddish brown (5YR [illegible], 5YR 4/4, 6/4). Clay films coating the pores and ped faces are reddish brown (5YR [illegible]). They are more prominent in appearance in places where the interior colors of the peds are brown or light brown. The very fine speckled or spotted appearance of the Bt horizon also occurs in places in the lower part of the A horizon. Moist colors of the B2t horizon are typically reddish brown or dark reddish brown (5YR 4/4, 3/4; 2.5YR 3/4), but are dark brown in the Bt horizon (7.5YR 4/4). The texture of the B2t horizon is sandy clay loam to clay loam. The structure is weak to moderate, angular blocky. The reaction is slightly acid to neutral.

The C horizon ranges from light brown to light yellowish brown (7.5YR 6/4; 10YR 6/4) and is brown or dark brown when moist (7.5YR 4/4; 10YR 5/3, 4/3). It is typically massive but in places shows some stratification. The texture is sandy loam to coarse sandy loam. It is neutral to mildly alkaline.

Ramona sandy loam (0 to 2 percent slopes) (Ra)—This soil is in both large and small areas. It has a profile that is very similar to that described as typical for the series. In its natural state, this soil is generally nearly level and its surface is smooth and even. In places, it is gently undulating. Low hummocks are not normally a part of the microrelief. The soil is well drained. The subsoil permeability is moderately slow. Runoff is slow, and there is no hazard of erosion. The available water holding capacity is high.

Included with this soil in mapping were very small areas of similar soils having a coarse sandy loam or fine sandy loam surface layer. Areas having a fine sandy loam surface layer are gently sloping. Also included is a small area having a sandy loam surface layer. The included areas that are gently sloping are along the edge of the foothills and in some foothill valleys.

Most areas of Ramona sandy loam have been smoothed or leveled and are cultivated. This soil is used for a wide variety of crops. Under proper management, good growth is obtained for alfalfa, corn, cotton, grain sorghum, and sugar beets. Very good growth of figs and oranges can be obtained. The location of the soil within the zone of minimum frost hazard, near the foothills, is important for successful orange groves. Grapes, peaches, and plums are well suited. Fertilizing with nitrogen and phosphorus is necessary for most crops.

Sulfur is important for legumes and may become increasingly needed by other crops. Growth of cotton improves with the addition of potassium fertilizer. Fairly long runs for furrow irrigation are possible in this soil. The intervals between irrigations can be well spaced and adequate moisture can still be maintained in the root zone. The actual interval depends upon the crop and the time of year. Forage production is fair. It can be significantly improved if rainfall is adequate by fertilizing with nitrogen, phosphorus, and sulfur. Capability unit I-1 (17, 18); range site not assigned; natural land type C2; Storie index rating 77.

Ramona loam (0 to 2 percent slopes) (Rc)—The profile of this soil is similar to that of Ramona sandy loam, but the subsoil is more commonly clay loam than sandy clay loam; also, the available water holding capacity is high. This nearly level soil is mainly in the vicinities of Fresno, Clovis, Sanger, and Orange Cove.

Included with this soil in mapping were a few minor areas of similar soils having a fine sandy loam or clay loam surface layer. Also included were some gently sloping areas.

The use and management of Ramona loam are similar to those of Ramona sandy loam. Most of the acreage is now under irrigation; nonirrigated areas are mainly in the foothill valleys. If the soil is cultivated when it is dry, it tends to be more cloddy than Ramona sandy loam. Dry clods are hard, and good seedbed preparation requires somewhat more effort. Plowpans form readily in the soil. Capability unit I-1 (17, 18); range site not assigned; natural land type C2; Storie index rating 85.

Ramona loam, gravelly substratum (0 to 2 percent slopes) (Rd)—A thick bed of rounded pebbles and cobblestones underlying the soil at a depth of 2 to 4 feet distinguish the profile of this soil from that of Ramona sandy loam. The pebbles commonly occur at a depth of about 3 feet. The soil is in a single large

area northeast of Centerville near the beginning of the northern part of the low alluvial terraces of the Kings River. Some small areas of Ramona loam were included in mapping

Internal drainage of this soil is impeded somewhat by the gravelly substratum. A zone of saturation builds up before water can move from the soil into the gravel, and roots do not explore the gravelly layer to any extent. The available water holding capacity is moderate

The entire acreage of this soil is irrigated. Water is obtained from district canals and from local wells The soil is used mainly for vineyards of table and raisin grapes. Some orange groves and some plum trees have been planted Somewhat more frequent irrigations are required on this soil than on Ramona sandy loam, in order to keep the root zone at optimum moisture content. In addition, the amount of water applied at each irrigation must be limited in order to avoid root damage from perched water above the gravel. Nitrogen and some phosphorus fertilizers are used. Capability unit IIs-0 (17); range site not assigned; natural land type C2; Storie index rating 70.

Ramona loam, hard substratum (0 to 2 percent slopes) (Rc)—The profile of this soil is similar to that of Ramona sandy loam, but has a loam surface and an unrelated, compact, weakly cemented sandy substratum. The substratum is normally several feet thick and underlies the soil at a depth of 2 to 4 feet. Locally, the substratum is called pack sand. It closely resembles the thick, weakly cemented layer that underlies the strongly cemented, platy hardpan of San Joaquin soils. Bulk density of the substratum is high, but the soil material contains many, very fine and microsize interstitial pores. Cementation appears to be mainly from iron compounds but also from silica. The substratum is very hard to extremely hard when dry and brittle to friable when moist. Widely spaced, thin vertical seams of hardened colloidal silica penetrate the substratum deeply; these seams follow a large, roughly polygonal pattern of cracking. In places the substratum is underlain by pale-colored, compact silt, loose sand, or moderately coarse textured old alluvium. The substratum impedes the internal drainage and causes some seasonal saturation in the subsoil from winter rains The available water holding capacity is moderate. This soil is widely distributed on the low terraces from Pinedale to Orange Cove.

About one-third of the acreage of this mapping unit consists of an included similar soil, located mainly in a large block near Centerville, that has a reddish-brown to dark reddish-brown clay layer overlying the substratum. The layer ranges from about ½ inch to 5 inches in thickness within short distances. In places there is a series of closely spaced fibers of clay within the normal subsoil. Also included with this soil in mapping were small areas of a similar soil having a clay loam surface layer

Ramona loam, hard substratum, is mainly under irrigation and is used for a wide variety of crops. These include cotton, alfalfa, irrigated barley, and some irrigated pasture, as well as raisin, table, and wine grapes, peaches, plums, figs, and oranges. The amounts of irrigation water applied should be carefully controlled for fruit trees and other deep-rooted crops so that the subsoil does not become saturated. Oranges are grown only in areas close to the edge of the foothills where the frost hazard is lowest. Nitrogen and phosphorus fertilizers are needed for most crops. Cotton responds to potassium. With increased use of phosphorus materials other than superphosphate, a need for sulfur may develop in this soil.

It is not generally possible to rip through the substratum to improve internal drainage. However, the effective depth of the soil can be increased by deep ripping at no more than 60 inches between shank centers. Ripping will shatter the upper parts of the substratum, to a depth of 1 or 2 feet, but the lower parts are only grooved by the tool blade (1) Deep chiseling or ripping of the soil in included areas mixes the thin clay layer with the thicker, coarser textured subsoil material The clay is effectively dispersed and does not flow back together on wetting. Capability unit IIs-3 (17), range site not assigned; natural land type C18; Storie index rating 65.

Ramona sandy loam, hard substratum (0 to 2 percent slopes) (Rb) The profile of this soil is similar to Ramona sandy loam, but it overlies an unrelated, compact, weakly cemented sandy substratum. The substratum is normally several feet thick and underlies the soil at a depth from 2 to 4 feet. This soil is widely distributed on the low alluvial terraces of the San Joaquin Valley.

Included with this soil in mapping was an area of a similar soil having a generally thin layer of reddish-brown clay overlying the substratum. The largest area of this included soil lies northwest of Centerville and west of Kirkman Hill

The use and management of Ramona sandy loam, hard substratum, are similar to those of Ramona loam, hard substratum. However, the frequency of irrigation for shallow-rooted crops is somewhat greater for this soil. In addition, the surface layer tends to be somewhat more easily tilled. Capability unit IIs-3 (17); range site not assigned; natural land type C18; Storie index rating 62.

Redding Series

The Redding series consists of well-drained soils that have a hardpan. These soils formed on high terraces in old gravelly or cobbly alluvium from mixed sources. They are gently undulating to rolling, and their surface has many low hummocks. Slopes are 0 to 15 percent. Cobblestones are generally on the surface in the intervening swales.

These soils are on remnants of high terraces southeast of Friant, north of Centerville, and south of Tivy Valley at elevations of 450 to 500 feet. The average annual precipitation ranges from 14 to 15 inches, the average annual temperature is about 62° F., and the average growing season is 275 days. The natural vegetation consists entirely of annual grasses and forbs.

In a typical profile, the surface layer is brown and reddish-brown, slightly acid gravelly loam about 9 inches thick. The subsoil is dark reddish-brown clay

that is strongly acid. It overlies a yellowish-red to red, iron-silica cemented, gravelly hardpan at a depth of 12 inches. The hardpan formed in the upper part of thick beds of gravelly material.

The Redding soils are used only for range. Sources of water are small intermittent streams. Ground water is very limited.

Representative profile in a protected, undulating area on an old, high terrace supporting a poor growth of annual grasses and forbs, on a southwest slope of 3 percent, at an elevation of 450 feet (about 2 miles, airline, SE. of the town of Friant, 200 feet N. of the bridge crossing the Friant-Kern Canal on the Thomas Ranch, and 70 feet E. of the canal, in the NW1/4NW1/4 sec. 21, T. 11 S., R. 21 E.):

A1—0 to 1 inch, brown (7.5YR 5/4) gravelly loam, dark reddish brown (5YR 3/4) when moist; massive, hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant fine and very fine roots; common fine tubular pores; strongly acid (pH 5.5); abrupt, wavy lower boundary.

A3—1 to 9 inches, reddish brown (5YR 5/4) gravelly loam, dark reddish brown (5YR 3/4) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful fine roots; common fine tubular pores; common thin clay films in pores; strongly acid (pH 5.4); abrupt, wavy lower boundary.

B2t—9 to 12 inches, dark reddish-brown (2.5YR 3/4) clay, dark red (2.5YR 3/6) when moist; strong, medium, prismatic structure; very hard when dry, firm when moist, sticky and plastic when wet; abundant fine roots between structural units, few very fine and fine tubular pores; continuous, moderately thick to thick clay films on ped faces; few pebbles; very strongly acid (pH 4.5), very abrupt, wavy lower boundary.

C1m—12 to 20 inches, yellowish-red to red (5YR 5/8 to 2.5YR 4/6), strongly cemented iron-silica gravelly hardpan; massive; clear, wavy lower boundary.

C2—20 to 60 inches +, variably colored, yellowish brown, reddish-brown, yellowish-red, and red gravelly coarse sandy loam, massive, hard when dry, firm to friable when moist, slightly sticky when wet; thin clay films on some pebbles; few thin clay seams; occasional lenses of loamy material, neutral (7.1), many feet thick.

The A horizon ranges from brown to reddish brown (7.5YR 5/4, 5YR 5/4). When the A1 horizon is moist, it ranges from reddish brown to dark reddish brown (5YR 5/4, 4/4, 3/4). Cobblestones tend to accumulate on the surface in the many swales. The reaction is slightly acid to strongly acid. The thickness of the A horizon ranges from about 6 to 12 inches.

The B horizon ranges from reddish brown to dark reddish brown (5YR 4/4, 3/4; 2.5YR 4/4, 3/4). When moist, it is dark reddish brown to dark red (2.5YR 3/4, 3/6). The texture is typically clay, but in places there are varying quantities of pebbles or cobblestones. The structure ranges from strongly prismatic to moderately or strongly angular blocky. The reaction is strongly acid to very strongly acid.

The gravelly C1m horizon is generally massive and strongly cemented, but in places it is somewhat platy or weakly cemented. The depth from the surface to the hardpan ranges from about 10 to 36 inches. The material in the C horizon below the hardpan is generally stratified, and the amount of pebbles and cobblestones varies within short distances. In places the C2 horizon is weakly consolidated. The texture of the C2 horizon ranges from gravelly coarse sandy loam to gravelly clay loam.

Redding gravelly loam, shallow, 0 to 9 percent slopes (RgB).—This soil is gently undulating to gently rolling and is generally associated with other soils that formed in material weathered from bedrock. It has a profile similar to that described as typical for the series. Runoff is slow to medium, but surface water stands in some swales until evaporated. The permeability of the soil is very slow because of the clay subsoil and gravelly hardpan. The available water holding capacity is very low. Roots do not readily explore the dense subsoil; consequently, root mats form on the top of the hardpan. The hazard of erosion is slight to moderate.

Included with this soil in mapping were small areas of a similar soil in which the coarse fragments are predominantly cobblestones, or the surface layer is gravelly clay loam.

Redding gravelly loam, shallow, 0 to 9 percent slopes, is used only for grazing. The forage is generally poor because of the very low fertility of the soil and the very low available water holding capacity. The best natural forage is produced when the rainfall is well distributed throughout the rainy season. If moisture is available and well distributed during the season, forage production can be improved by fertilizing with nitrogen, phosphorus, and sulfur. Capability unit VIe-3 (17); range site 8, natural land type D28-4p; Storie index rating 14.

Redding gravelly loam, 3 to 15 percent slopes (RfC).—The profile of this soil is similar to that described as typical for the series, but the depth to hardpan is commonly about 30 inches and ranges from 20 to 36 inches. There are many cobblestones in the soil. The available water holding capacity is low. It is about twice that of Redding gravelly loam, shallow, 0 to 9 percent slopes.

Included with this soil in mapping were small areas of a similar soil that has a gravelly or cobbly clay loam surface layer.

The use and management of Redding gravelly loam, 3 to 15 percent slopes, are similar to those of Redding gravelly loam, shallow, 0 to 9 percent slopes. Because of its somewhat better water holding capacity, forage production is somewhat better during years of less evenly distributed rainfall. Capability unit IVe-3 (17); range site 8; natural land type D28-4p; Storie index rating 19.

Riverwash (Rh) consists of areas of deep sand and gravel that are adjacent to, or occur as islands within, the low water channels of the Kings and San Joaquin Rivers and many of the small intermittent streams. At normal high water, parts of these areas are inundated, and under flood conditions, nearly all are flooded. At present, however, floods on the rivers are generally controlled by large dams.

Some areas of this land type consist of smooth sandbars. Others consist of intermingled gravel, cobblestones, and stones that are heaped into low ridges separating sandy stringers. Many of the large areas include small islands of Hanford, Visalia, and Grangeville soils that have a gravelly substratum.

Generally, vegetative cover is lacking in Riverwash, but in places there are scattered willows, sycamores, and some brushy plants. Except for the included areas,

this land type has little or no value for browse and no value for farming. Its greatest value lies in its use as recreational sites and as a source of aggregate material for road building or general construction. Capability unit VIIIw-4 (17); range site 11; natural land type A14, Storie index rating 5.

Rocklin Series

The Rocklin series consists of well-drained soils that are moderately deep to a hardpan and have a heavy sandy loam to sandy clay loam subsoil. The soils formed from the weathering of moderately coarse textured granitic sediments exposed by the slow dissection of the edges of the large, low alluvial terrace of the San Joaquin River between Herndon and Friant. The soils are mainly gently rolling; in some areas there are many low hummocks. Slopes are 3 to 9 percent.

The Rocklin soils are at elevations of 300 to 500 feet. The average annual precipitation ranges from about 10 to 14 inches. The average annual temperature is about 62° F., and the average growing season is 250 days. The natural vegetation consists entirely of annual grasses and forbs.

In a typical profile, the surface layer is brown, medium acid to slightly acid sandy loam about 8 inches thick. The subsoil is neutral, brown sandy loam and brown sandy clay loam. The subsoil is underlain at a depth of 31 inches by a reddish-brown hardpan that is strongly cemented with silica in the upper part. Small amounts of iron oxide contribute to the cementation.

The Rocklin soils in this survey area have limited use. Little or no irrigation water is available for most of the acreage, but at lower elevations some water is available from irrigation district canals.

Representative profile in an undulating idle area near the dissected bluffs bordering the low terraces of the San Joaquin River, under a cover of annual grasses and forbs, on a north facing slope of about 7 percent, at an elevation of 340 feet (about 1¼ miles NW. of Pinedale; W. side of a deeply incised, abandoned drainage trench, 400 feet N. of the junction of Alluvial and Teilman Avenues, in the SW¼SW¼NW¼ of sec. 32, T. 12 S., R. 20 E.):

A11—0 to 3 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) when moist; massive; hard when dry, very friable when moist, nonsticky and nonplastic when wet; plentiful fine and microsize roots; few microsize and fine tubular pores, very few medium tubular pores containing bundles of microsize roots; medium acid (pH 6.0); abrupt, smooth lower boundary.

A12—3 to 8 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) when moist; massive; hard when dry, very friable when moist, nonsticky and nonplastic when wet; few fine and microsize roots; few to common microsize tubular pores, very few fine and medium tubular pores containing bundles of microsize roots; slightly acid (pH 6.3); clear, smooth lower boundary.

B1—8 to 17 inches, brown (10YR 5/3, 7.5YR 5/4) sandy loam, dark brown (10YR, 7.5YR 3/4) when moist; weak, medium to fine subangular blocky structure; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; plentiful fine and microsize roots, few fine tubular pores, common very fine tubular pores, many microsize interstitial pores, very few thin clay coatings on grains and as bridging; neutral (pH 7.0); clear, wavy lower boundary.

B21t—17 to 23 inches, brown (7.5YR 5/4) heavy sandy loam, dark brown (7.5YR 3/4) when moist; weak, coarse, subangular blocky structure; very hard when dry, friable when moist, sticky and slightly plastic when wet; few microsize roots; pores similar to those in B1 horizon; few thin clay films in pores, common bridging of sand grains; neutral (pH 7.0); clear, wavy lower boundary.

B22t—23 to 31 inches, brown (7.5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; weak, coarse, prismatic structure; very hard when dry, friable when moist, sticky and slightly plastic when wet; very few microsize roots, many fine and very fine tubular pores; few thin clay films on ped faces, interstitial pores filled with clay; neutral (pH 7.0); very abrupt, wavy lower boundary.

Cm—31 to 60 inches, reddish-brown (5YR 4/4) strongly cemented hardpan, dark reddish brown (5YR 3/4) when moist; very coarse platy structure and widely spaced, vertical cracks coated with white or buff-colored silica material; cracks intersect to form very large polygonal units 2 to 4 feet thick; horizontal plates most strongly cemented (extremely hard) in upper part; grades into a weakly cemented, but dense sandy material below depth of 43 inches; grades further to loose sand or compacted silty material below depth of 60 inches.

The A horizon ranges from brown to light brown (10YR 5/3, 7.5YR 6/4, 5/4). When this horizon is moist, it is generally dark brown (10YR 3/3, 4/3, 7.5YR 3/4). The texture is commonly sandy loam, but there are small areas of fine sandy loam. Reaction ranges from medium acid to slightly acid.

The B horizon is brown or reddish brown (7.5YR 5/4; 5YR 4/4, 5/4) and is dark brown to dark reddish brown when moist (7.5YR 3/4; 5YR 3/4). The texture ranges from heavy sandy loam to sandy clay loam. The structure is subangular blocky or angular blocky to prismatic. Reaction is slightly acid to neutral.

The depth to hardpan (Cm horizon) ranges from about 20 to 36 inches. The degree of cementation of the hardpan ranges from strong to indurated; there are irregular interruptions of weakly cemented material. The thickness of the strongly cemented Cm horizon ranges from about 6 to 15 inches. The dense, sandy material below the Cm horizon ranges from 1 to 3 feet in thickness. It is underlain by pale stratified silt and sand.

Rocklin sandy loam, 3 to 9 percent slopes (RkB).—This soil has the profile described as typical for the series. The soil is mainly gently rolling. Zones of saturation above the hardpan build up in low spots during the rainy season. The permeability of the soil is moderate, but the permeability of the hardpan is very slow. Water in the soil commonly moves downslope along the surface of the hardpan. Runoff is medium, the available water holding capacity is low, and the hazard of erosion is slight to moderate.

Included with this soil in mapping were small areas of a similar soil in which the depth to hardpan is less than 20 inches. Also included was a minor area that is rolling or strongly sloping. These included areas are east of Herndon and northeast of Pinedale.

Rocklin sandy loam, 3 to 9 percent slopes, is used principally for grazing and for dryfarmed barley. Some improvement in forage growth and palatability can be obtained by fertilizing with nitrogen, phosphorus, and sulfur. Some areas are used to grow figs or

irrigated pasture. A small area is used as part of a golf course. Some areas are used for homesites. The soil is well suited to irrigated pasture, particularly if sprinklers are used. The planting sites of all trees are either deeply ripped or individually blasted to break the hardpan. Capability unit IIIe-8 (17); range site 8; natural land type E1; Storie index rating 28

Rocklin Series, Pumiceous Variant

The Rocklin series, pumiceous variant, consists of well-drained to somewhat excessively drained soils that are shallow over an iron-silica cemented hardpan. These soils formed in old moderately coarse textured granitic sediments that contained a large quantity of pumice. They are mainly gently rolling but range to rolling or sloping. Some areas have many low hummocks. Slopes are 3 to 30 percent.

These soils occur in several small areas near Friant, at elevations of about 400 to 500 feet. The average annual rainfall is about 14 inches, average annual temperature is about 62° F., and the average growing season is about 250 days. The natural vegetation consists of annual grasses and forbs.

In a typical profile, the surface layer is pale-brown sandy loam about 9 inches thick. The subsoil is pale-brown sandy clay loam. At a depth of about 13 inches is an iron-silica cemented hardpan about 2 inches thick. Below this hardpan is mixed granitic and pumiceous materials that are softly consolidated.

The pale-brown colors throughout the profile, strongly acid subsoil, and scattered areas where the cemented hardpan is exposed distinguish the pumiceous variant from the typical Rocklin soils

Representative profile in an area of native range consisting of annual grasses and forbs, on rolling to hilly remnants of an old river terrace of granitic and pumiceous material having outcrops of hardened parent sediments, on an easterly slope of 20 percent at an elevation of 450 feet (about 1¼ miles SE. of the town of Friant, 100 feet N. of the center NW¼ of sec. 17, T. 11 S., R. 21 E.):

A1—0 to 9 inches, pale brown (10YR 6/3) sandy loam, dark brown (10YR 4/3) when moist; massive; hard when dry, friable when moist; plentiful microsize roots; many microsize interstitial pores; slightly acid (pH 6.5); abrupt, wavy lower boundary.

B2t—9 to 13 inches, pale-brown (10YR 6/3) sandy clay loam, dark brown (7.5YR 4/4) when moist; moderate, medium, subangular blocky structure; hard when dry, friable when moist, sticky and slightly plastic when wet; plentiful microsize roots; very few microsize tubular pores; common microsize interstitial pores; common thin clay films on ped faces and in pores; clay films are yellowish brown (10YR 5/4) when dry, dark brown (10YR 4/3) when moist; strongly acid (pH 5.5); abrupt, broken lower boundary

C1m—13 to 15 inches, very pale brown (10YR 7/3) strongly cemented iron-silica hardpan that crushes to gravelly sandy loam (pebbles are pumiceous fragments); yellowish brown (10YR 5/4) when moist; massive; extremely hard, abrupt, irregular lower boundary.

C2—15 inches +, light-brown, weakly consolidated sediments of mixed granitic and pumiceous materials.

There is little variation in the A horizon. The distribution of outcrops of parent rock or hardpan is uneven. Most outcrops are located in a rim around the edges of flattened tops of knolls or low ridges.

The B horizon is somewhat variable. Its texture ranges from heavy sandy loam to sandy clay loam. The reaction ranges from slightly acid to strongly acid. The lower boundary is abrupt and broken or wavy. In some places where the boundary is broken, tongues of material from the B2t horizon cut through the hardpan. Thin lenses of soil material similar to that of the B2t horizon underlie the hardpan in places. The depth to the hardpan ranges from about 10 to 24 inches.

Rocklin sandy loam, pumiceous variant, 3 to 30 percent slopes (RIO).—This soil has the profile described as typical for the Rocklin series, pumiceous variant. It occurs in several small areas near the town of Friant. Included in mapping were small areas where the depth to hardpan ranges from 30 to 48 inches

The permeability of the soil is moderate. The hardpan is very slowly permeable, but its irregular broken form permits some internal drainage. The hazard of erosion ranges from slight to high, depending upon the slope. The available water holding capacity is very low

The soil is used only for grazing. Fertilization with nitrogen, phosporus, and sulfur can increase the growth of forage and improve palatability, if moisture is adequate. Across the San Joaquin River in Madera County, pumiceous sediments that form similar soils have provided materials for manufacturing brick. Capability unit IVe-3 (17); range site 8; natural land type E5; Storie index rating 17.

Rossi Series

The Rossi series consists of saline-alkali affected soils that have a clay loam subsoil. These soils of the basin lands developed under somewhat poorly drained to poorly drained conditions in medium-textured to moderately fine textured granitic alluvium. The soils are generally smooth and nearly level. Slopes are 0 to 2 percent. In places, however, they are cut by shallow, meandering streams that are part of local patterns of drainage from the adjacent, higher lying basin rim.

The Rossi soils occupy an irregular band along the eastern edge of the basin flood plain, extending from Whites Bridge to the general vicinity of Riverdale. They are at elevations of 170 to 200 feet. The average annual precipitation is 8 inches, the average annual temperature is about 63° F., and the average growing season ranges from about 275 days near Whites Bridge to 225 days near Helm and Riverdale. The natural vegetation consists of saltgrass, salt- and alkali-tolerant shrubs, and some annual grasses and forbs.

In a typical profile, the surface layer is gray, moderately alkaline fine sandy loam about 12 inches thick The subsoil is very strongly alkaline, slightly calcareous to strongly calcareous, mottled, olive and pale-yellow clay loam that has prismatic structure in the upper part and angular blocky structure in the lower part. At a depth of about 38 inches it grades into

stratified alluvium that is pale colored but mottled and very strongly alkaline.

Most of the acreage of the Rossi soils is uncultivated and is used for grazing. Some areas have been leveled and reclamation has been attempted. The soils are reclaimed very slowly, but some irrigated field crops have been established. Irrigation water is obtained mainly from wells, but some water is available from irrigation district canals.

Representative profile in a level fallow field, at an elevation of 175 feet (about 3 miles ESE. of the town of San Joaquin, 1,750 feet W., 100 feet S. of the Manning Avenue bridge over the Fresno Slough bypass, in the NE¼NE¼ of sec. 29., T. 15 S., R. 17 E.):

Ap1—0 to 4 inches, gray (5Y 5/1) fine sandy loam, very dark gray (5Y 3/1) when moist, massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful fine roots, few fragments of material from B2t horizon incorporated by deep tillage; moderately alkaline (pH 7.9); abrupt, wavy lower boundary.

Ap2—4 to 12 inches, similar in characteristics to Ap1 horizon, except that it is hard when dry; abrupt, wavy lower boundary.

B21t—12 to 20 inches, olive (5Y 5/3) clay loam, dark olive (5Y 3/3) when moist; common, fine, prominent mottles of yellowish red and many, medium, distinct lime mottles of pale yellow; moderate, coarse, prismatic structure; very hard when dry, very firm when moist, sticky and plastic when wet, few fine roots, mainly along structural cracks; many moderately thick clay films and black stains of organic matter on ped faces; slightly calcareous, very strongly alkaline (pH 9.1); abrupt, wavy lower boundary.

B22tca—20 to 38 inches, pale-yellow (5Y 7/3) clay loam, olive (5Y 5/3) when moist; few, fine, prominent mottles of yellowish red and few, fine faint lime mottles of pale olive; moderate, medium, angular blocky structure, hard when dry, friable when moist, slightly sticky and plastic when wet, few fine roots, few thin clay films on ped faces; strongly calcareous; very strongly alkaline (pH 10.2); clear, smooth lower boundary.

C1ca—38 to 49 inches, pale-yellow (5Y 7/4) loam, olive (5Y 5/4) when moist; few, fine, prominent mottles of yellowish red and few, fine, faint lime mottles of pale olive, mottling primarily along root channels, massive, slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet, few fine roots; strongly calcareous; very strongly alkaline (pH 10.3); clear, smooth lower boundary.

C2—49 to 53 inches, pale-olive (5Y 6/3) loam, olive (5Y 4/3) when moist; common, medium, prominent mottles of yellowish red and reddish brown and few, fine, faint lime mottles of pale yellow, mottling primarily along root channels, massive, slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet, few fine roots, slightly calcareous, very strongly alkaline (pH 10.4); abrupt, wavy lower boundary.

IIC3—53 to 66 inches, pale-yellow (5Y 7/4) loamy sand, olive (5Y 5/4) when moist, many fine, prominent mottles of yellowish red, massive (single grain); loose when dry or moist, nonsticky and nonplastic when wet, very strongly alkaline (pH 10.2), abrupt, wavy lower boundary.

IIC4—66 inches +, white (5Y 8/1) sand, gray (5Y 6/1) when moist, common, medium, prominent mottles of pink and many fine prominent mottles of yellowish brown, single grain, loose when dry or moist, nonsticky and nonplastic when wet, very strongly alkaline (pH 9.1).

The A horizon is gray or dark gray. The hue is 10YR, 2.5Y, or 5Y, the value is 4 or 5, and the chroma is generally 1 but in places is neutral. When this horizon is moist, the color darkens to very dark gray, very dark grayish brown, or dark olive gray. The hue is similar, the chroma is 1 or 2, and the value is only 3. In cultivated areas the A horizon is somewhat lighter colored because leveling has mixed some of the lighter colored material from the B horizon into the A horizon. The A horizon is generally massive or cloddy, and the dry consistence is slightly hard to hard. The reaction is moderately alkaline to strongly alkaline. Little or no effervescence occurs when dilute hydrochloric acid is applied unless the A horizon is saline-alkali affected. In uncultivated areas the A1 horizon is about 3 to 6 inches thick and generally overlies the B2t horizon abruptly. In cultivated areas the Ap horizon is thicker in places because of land leveling or smoothing. The texture of the A horizon is fine sandy loam, loam, or clay loam.

The B2t horizon varies in shades of olive in the upper part (5Y 4/3, 4/4, 5/3, 5/4) and lightens to pale yellow or pale olive in the lower part (5Y 7/3, 6/3, 6/4). When moist, it is dark olive to olive (5Y 3/3, 5/3). Mottling is typical. Oxide mottles are distinct to prominent and vary from few to many and fine to medium. Pale-colored lime mottles are faint to distinct and range from few to many. The grade of structure is weak to moderate. The coarse prismatic peds normally break readily into medium angular or subangular blocks. Dry consistence is hard to very hard. The texture is sandy clay loam or clay loam. Reaction is strongly alkaline to very strongly alkaline. Lime occurs as variable soft masses, nodules, or threads.

The C horizon is variably stratified with medium-textured to coarse-textured granitic alluvium. It is less calcareous than the B horizon or in some places is noncalcareous. If lime is present, it is generally disseminated.

Rossi fine sandy loam (0 to 2 percent slopes) (Rs).—This nearly level soil has the profile described as typical for the series. Its surface layer is not generally saline-alkali affected. The subsoil is uniformly strongly or very strongly alkaline and has an accumulation of at least a slight amount of salts. Areas of this soil that have been leveled normally show very light colored spots when fallow. These are exposures of former subsoil material.

The drainage in the soil has been improved because of flood control dams on the rivers and because of the general lowering of the local water table to a depth of 40 feet or more. The soil is now generally moderately well drained. Runoff and permeability are slow. The available water holding capacity is moderate, but if the soil is reclaimed, the available water holding capacity is high. There is generally no hazard of erosion, except along the main bypass floodway of the Fresno Slough. Here, there is a hazard of deposition from transported sands. Widely spaced gullies in a trellis pattern have cut into the soil where subsiding floodwaters drain back into the deeper main floodway channel.

Included with this soil in mapping were small areas of a similar soil that has a sandy loam surface layer, of a soil that has a sandy clay subsoil, and of a soil that has a compact silty substratum at a moderate depth.

Much of the acreage of Rossi fine sandy loam is used only for alkali pasture. Attempts are being made to reclaim this soil. Because of the slowly permeable subsoil and the strong effects of excess salts and alkali, reclamation is spotty and slow. The soil is well suited to irrigated pasture and rice. Some areas have been

partly reclaimed and planted to alfalfa for seed and to cotton. Capability unit IVs–6 (17); range site not assigned; natural land type B2–2a; Storie index rating 32.

Rossi clay loam (Rs).—This soil has a profile that is similar to that of Rossi fine sandy loam except for its clay loam surface layer. It is in small areas along the eastern edge of the basin northwest of Burrel. Some small areas of this soil are islands within larger areas of Merced soils. A fairly large proportion of the surface layer is saline-alkali affected.

The use and management of this soil are similar to those of Rossi fine sandy loam. This soil is more difficult to reclaim and tends to be more cloddy under cultivation. Capability unit IVs–6 (17); range site not assigned; natural land type B2–2a; Storie index rating 27.

Sandy alluvial land (Sa) consists of sandy material deposited by floodwater that has been diverted into the Fresno Slough bypass in places along the eastern side of the flood channel. This material has taken the form of a natural levee. The material is pale-colored, stratified loamy fine sand and fine sandy loam that have been deposited over Rossi soils. The material is neutral to mildly alkaline and is prominently mottled with yellowish brown below a depth of about 10 inches. The thickest part, which ranges from about 36 to 48 inches in thickness, is nearest the flood channel. Away from the channel, the material becomes thinner until it merges with the surface layer of the underlying Rossi soils.

This land type is in the floodway mainly northeast of the town of San Joaquin. It is subject to seasonal flooding. The permeability of the sandy material is rapid, but internal drainage is impeded by the buried Rossi soils. Runoff is slow. The hazard of erosion is variable, depending upon the flood conditions. There may be either additional deposition of material or the banks may be cut away. The available water holding capacity of the material is moderate.

Sandy alluvial land is used only for grazing. This land type is not used for farming at this time because of its location in the floodway easement. Capability unit IIw–2 (17); range site not assigned; natural land type A2–1o; Storie index rating 19.

Sandy alluvial land, leveled (Sb) has been formed as man developed cropland in the basin. The material that makes up this land type was the parent material of Piper or Rossi soils. It has been exposed by drastic land leveling operations and consists mainly of deep, light gray to very pale brown, calcareous sandy loam.

Areas of this land type occur as small islands within large areas of finer textured Merced or Temple soils. Where these areas are in the basin, they are probably related to former areas of Piper soils on remnants of natural levees along old sloughs. Where they lie near the eastern edge of the basin, they are related to previously existing areas of Rossi soils.

Sandy alluvial land, leveled, is now well drained, but many reddish or yellowish mottles reflect a past history of poor or somewhat poor drainage. In places at a depth of 1 or 2 feet, there is a layer of loamy sand or sand. The permeability is moderate to rapid. Runoff is slow; erosion is not a hazard. The available water holding capacity is moderate.

Included with this land type in mapping were areas of similar materials that are saline-alkali affected. Spot symbols have been used on the soil map to indicate those affected areas.

Areas of this land type are usually in larger areas mapped as soils, mainly the Merced or Temple soils, which are used for such irrigated crops as cotton, alfalfa seed, barley, and rice. Crops generally lack adequate moisture because of the sandy texture of the soil material. Plants grown on Sandy alluvial land, leveled, generally need nitrogen and phosphorus fertilizers and respond well to these fertilizers if soil moisture can be maintained. Saline-alkali affected areas can be improved if treated with enough gypsum to replace the sodium held by the clay-sized particles in the soil material. Fields having many sandy areas are not desirable for rice, because it is difficult to maintain water in those areas. Capability unit IIs–4 (17); range site not assigned; natural land type B1; Storie index rating 76.

San Joaquin Series

The San Joaquin series in this area consists of well-drained soils formed from old granitic alluvium. These soils have a thin clay layer in the subsoil and are moderately deep to a strongly cemented hardpan. They are nearly level to gently rolling and have many rounded hummocks or swales, and these cause the hogwallow microrelief. Slopes are 0 to 9 percent.

The soils occupy large areas of the low alluvial terraces of the San Joaquin River and Kings River, as well as those of the larger creeks draining the foothills. They are at elevations of 250 to 500 feet. The average annual precipitation ranges from 9 to 16 inches, the average annual temperature is 62° F., and the average growing season ranges from 250 to 275 days. The natural vegetation consists entirely of annual grasses and forbs. A variety of unusual plants normally cluster around the ephemeral pools that form in some intermound swales during the spring.

In a typical profile, the surface layer is slightly acid to medium acid, brown and light yellowish brown loam about 8 inches thick. The subsoil consists of slightly acid layers of brown and reddish-brown loam, sandy clay loam, and clay. At a depth of a little more than 28 inches is a strongly cemented iron-silica hardpan about 6 inches thick. Below this are several feet of dense weakly cemented sandy material.

In places where these soils are not irrigated, they are used for grazing or dry pasture and some dry-farmed barley. Under irrigation and intensive management, they are used for figs, olives, vineyards, deciduous fruit, oranges, cotton, and irrigated pasture. Water for livestock is obtained from shallow wells with wind-powered pumps and from intermittent streams. Irrigation water is obtained from deeper wells and from irrigation district canals.

Representative profile in a nearly level idle area on

a low terrace of the San Joaquin River, under a cover of annual grasses, forbs, and weeds, at an elevation of 335 feet (1 mile W. of Pinedale, near an abandoned drainage canal on the N. side of Herndon Avenue in the SE¼SW¼SW¼ of sec. 32., T. 12 S., R. 20 E.):

A11—0 to 2 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; weak fine granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful fine roots; few fine tubular pores; slightly acid (pH 6.[illegible]); abrupt, wavy lower boundary.

A12—2 to 3 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; very few fine tubular pores; medium acid (pH 5.9); abrupt, wavy lower boundary.

A3—3 to 8 inches, light yellowish-brown (10YR 6/4) loam, dark brown (7.5YR [illegible]) when moist; massive, hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; few fine tubular pores, common very fine tubular pores; medium acid (pH 5.9); abrupt, wavy lower boundary.

B1—8 to 16 inches, brown (7.5YR 5/4) loam, reddish brown (5YR 4/4) when moist; when dry many tiny patches of light brown (7.5YR 6/4) give peds a speckled appearance; generally massive, but in places tends to have weak, coarse, prismatic structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; common fine tubular pores, many very fine tubular pores; clay occurs mostly as grain coatings and interstitial pore fill; slightly acid (pH 6.4); clear, wavy lower boundary.

B21t—16 to 28 inches, reddish-brown (5YR 4/4) sandy clay loam, yellowish red (5YR 4/6) when moist; light-brown patches similar to those seen in B1 horizon; weak, coarse, prismatic structure breaking to weak, coarse, angular blocky structure; very hard when dry, friable when moist, sticky when wet; few fine roots; few fine tubular pores, many very fine tubular pores; few to common thin clay films on ped faces and in pores; slightly acid (pH 6.5); abrupt, wavy lower boundary.

B22t—28 to 28½ inches, reddish-brown (5YR [illegible]) [illegible], dark reddish brown (5YR 3/4) when moist; strong, thin to medium, platy structure; very hard when dry, firm when moist, sticky and plastic when wet; nonporous; root mat rests on top of horizon; slightly acid (pH 6.5); very abrupt, wavy lower boundary.

IIC1m—28½ to 30 inches, strongly cemented iron-silica hardpan; dark stains of manganese dioxide on surface; reddish-yellow to strong-brown seams of cementing materials ramify densely packed, pale-brown sandy matrix; strong thick platy structure; extremely hard, nonporous but occasionally fractured; a few small seams of lime in lower part; gradual, smooth lower boundary.

IIC2—30 to 60 inches +, pale-brown (10YR 6/3) coarse sandy loam, yellowish brown (10YR 5/4) when moist; massive; very hard to extremely hard, friable to firm or brittle when moist; material densely packed and may be weakly cemented, grain to grain; in places widely spaced vertical seams of cementing agents; neutral (pH 7.2); several feet thick, underlain by light-gray to white, very fine sand and compacted silt.

The soil described in the foregoing profile is covered with a sparse litter of dried grasses and forbs.

The A horizon ranges from brown (10YR 5/3, 4/3, 7.5YR 5/4, 4/4) to reddish brown (5YR 4/3, 4/4, 5/3, 5/4). When this layer is moist, it is dark brown (10YR 4/3, 3/3; 7.5YR 4/4) to dark reddish brown (5YR 3/3, 3/4). It is typically massive, but in some undisturbed areas the upper few inches of the A1 horizon has weak, granular structure. The reaction ranges from medium acid to neutral. Texture is sandy loam, fine sandy loam, or loam. The thickness of the A horizon ranges from about 6 to 10 inches.

The B2t horizon varies in shades of reddish brown (5YR 4/3, 4/4, 5/3, 5/4). Moist colors are generally dark reddish brown (5YR 3/4) or yellowish red (5YR 4/6), but in a few places the moist color is dark red (2.5YR 3/6) in the lower part of the horizon. The texture of the B21t horizon is sandy clay loam or clay loam. The B22t horizon is sandy clay or clay. The structure of the B21t horizon is weak to strong, angular or subangular blocky, or weak to strong, coarse prismatic. The B22t horizon has strong, thin to medium, platy structure or strong, medium, angular blocky structure, depending on the thickness of the horizon. The B21t horizon ranges in thickness from about 6 to [illegible] inches, the B22t horizon, from about ¼ inch to 8 inches. The reaction of the B horizon is slightly acid to neutral.

The hardpan (IIC1m horizon) is brown, pale brown, reddish brown, or yellowish red, and is commonly variegated with these colors. The depth to hardpan ranges from about 12 to 48 inches. The hardpan varies considerably in thickness; its thickness ranges from about 6 inches to several feet. The most strongly cemented part is in the upper 6 to 24 inches. In some places it is massively cemented, but in many places it separates into cemented layers a few inches thick, interspaced by material similar to that in the IIC2 horizon. The distance between the cemented layers increases with depth, and the degree of cementation decreases. In some places the IIC2 horizon is pale-brown, brown, or yellowish-brown, densely compacted, weakly cemented coarse sandy loam. In other places this horizon is very pale brown to white, compacted, very fine sand and silt.

San Joaquin loam, 0 to 3 percent slopes (SeA).—This soil has the profile described as typical for the series. The horizon of clay is thicker in areas where the soil lies on terraces deposited by the Kings River or smaller streams such as Dog Creek, Fancher Creek, and Wahtoke Creek than it is in other areas. In places where the soil formed in old alluvium from the San Joaquin River, it tends to have a thinner B22t horizon and a surface layer that is somewhat gritty. The depth to hardpan ranges from about 24 to 48 inches, but is typically about 30 inches.

Runoff is slow. In undeveloped areas, surface water is ponded in some intermound swales. Because of the hardpan and the clayey horizon overlying it, the permeability of the soil is very slow. The subsoil generally becomes saturated for short periods during the rainy season. The available water holding capacity is commonly low but ranges from very low to moderate, depending upon the depth of soil. The erosion hazard is none to slight.

Included with this soil in mapping were small areas that have a fine sandy loam surface layer. A minor area whose slope ranges from about 3 to 9 percent was also included. These included areas occupy small swales or beveled parts of the terraces.

The undeveloped areas of San Joaquin loam, 0 to 3 percent slopes, are used for grazing and some dry-farmed barley. Some improvement in the growth of forage can be obtained by fertilizing with nitrogen, phosphorus, and sulfur, if the amount and distribution of rain are adequate. Nitrogen and phosphorus can increase the growth of barley. However, this also depends upon the amount of rainfall.

A large acreage of this soil is irrigated and used for many kinds of crops. Crops are raisin, table, and wine

grapes, plums, cotton, alfalfa, irrigated pasture, and oranges. Oranges generally are grown in parts of the valley near the edge of the foothills. Use of this soil for successful growth of irrigated crops requires breaking up the hardpan by blasting or ripping and leveling of the surface. In certain areas northwest of Fresno, blasting was used in planting extensive fig orchards, but blasting is seldom used now. Deep ripping is the method now in common use to break up the hardpan. Ripping improves internal drainage and, if properly done, effectively deepens the soil. The firmly packed material beneath the hardpan, not broken by ripping, slows internal drainage. Nitrogen and phosphorus are the main plant nutrients required in irrigated areas of this soil. Care is needed in irrigating deep-rooted crops to avoid saturation of the subsoil. Capability unit IIIs-8 (17); range site 8; natural land type C13; Storie index rating 33.

San Joaquin sandy loam, 0 to 3 percent slopes (ScA).—This soil has a profile that is similar to that of San Joaquin loam, 0 to 3 percent slopes. It is widely distributed throughout most of the low terraces. The available water holding capacity of this soil is slightly less than that of San Joaquin loam, 0 to 3 percent slopes.

Included with this soil in mapping were many small areas of Exeter sandy loam and Ramona sandy loam, hard substratum. These included areas are widely distributed, but most are on the low terraces of the San Joaquin River.

The use and management of San Joaquin sandy loam, 0 to 3 percent slopes, are similar to those of San Joaquin loam, 0 to 3 percent slopes. Capability unit IIIs-8 (17); range site 8; natural land type C13; Storie index rating 31.

San Joaquin sandy loam, shallow, 0 to 3 percent slopes (SdA).—The profile of this soil is similar to that of San Joaquin loam, 0 to 3 percent slopes, but the subsoil is thinner and the hardpan is at a depth of 12 to 24 inches. Much of the original surface layer has been removed or mixed with the upper layers of the subsoil. The soil is mainly on the low terraces of the San Joaquin River and Dry Creek, but some areas are also near Sanger and Navelencia on the low terraces of Fancher Creek, the Kings River, and Wahtoke Creek. The available water holding capacity of this soil is very low.

Included with this soil in mapping were some small areas northeast of Centerville of Exeter sandy loam, shallow.

The use and management of San Joaquin sandy loam, shallow, 0 to 3 percent slopes, are similar to those of San Joaquin sandy loam, 0 to 3 percent slopes. A large acreage is used successfully for figs. If rainfall is not distributed evenly in winter and spring, production of forage and dryfarmed barley is low. Capability unit IIIs-8 (17); range site 8; natural land type C13; Storie index rating 23.

San Joaquin sandy loam, shallow, 3 to 9 percent slopes (SdB).—The profile of this soil is similar to that of San Joaquin loam, 0 to 3 percent slopes, but the subsoil is thinner and the hardpan is at a depth of 12 to 24 inches. The soil occupies broad drainage swales and undulating areas on low terraces. It is mainly on the low alluvial terraces of the San Joaquin River and Dry Creek. Runoff is slow to medium, and the hazard of erosion is moderate.

The soil is used for grazing, irrigated pasture, and a small area is planted to figs. Some areas are idle; those near Fresno or other nearby towns will likely be used as homesites. Irrigation is accomplished by contour checks and basins. Sprinklers are used for irrigated pastures. Capability unit IVe-8 (17); range site 8; natural land type C13; Storie index rating 20.

San Joaquin loam, gravelly substratum, 0 to 3 percent slopes (SfA).—The profile of this soil is similar to that of San Joaquin loam, 0 to 3 percent slopes, but it overlies a thick deposit of rounded pebbles and cobblestones at a depth ranging from 2 to 4 feet but averaging about 2½ feet. The hardpan development is variable. In places it consists of a cemented layer of sandy material, 3 to 6 inches thick, that is directly underlain by the gravel layer. In other places the upper part of the gravelly layer has a weakly to strongly cemented sandy matrix forming a gravelly or cobbly pan as much as 20 inches thick. Below this the sandy matrix is uncemented. In some places the lower part of the subsoil is gravelly. The soil is north and northeast of Centerville on the apex of an old fan or low terrace of the Kings River.

The soil is used mainly for vineyards. Grapes grow well. The management of this soil is similar to that of San Joaquin loam, 0 to 3 percent slopes. Leveling and ripping generally bring much of the gravel or cobblestones to the surface, and this limits cultivation. Capability unit IIIs-8 (17); range site not assigned; natural land type C13; Storie index rating 33.

San Joaquin loam, shallow, 0 to 3 percent slopes (SeA).—The profile of this soil is similar to that of San Joaquin loam, 0 to 3 percent slopes, but it has a thinner subsoil. The clay layer within the subsoil is directly over the hardpan, which is at a depth of 21 to 24 inches. This clay layer ranges from about 2 to 8 inches in thickness.

Included with this soil in mapping were small areas of a similar soil that has a fine sandy loam surface layer. Also included were small areas in which the depth to hardpan is as much as 36 inches. These included areas are northeast of Pinedale, west of Sanger, and north of Reedley.

The use and management of San Joaquin loam, shallow, 0 to 3 percent slopes, are similar to those of San Joaquin loam, 0 to 3 percent slopes. However, under natural conditions the available water holding capacity is very low to low. Therefore, for most irrigated crops it is important that effective ripping be done to develop a larger volume of soil material for better root development and greater available moisture holding capacity. The distance between passes of the ripper shank should be no more than 60 inches for optimum effect. After ripping and leveling, fragments of hardpan generally need to be cleared from the surface. Depth of hardpan is not critical for irrigated pasture. Leveling to control irrigation water is of greater importance. Figs are grown in large areas of this soil. The natural shallowness of the soil was al-

tered by individual blasting of the hardpan at each planting site. Some of the fig orchards are being replaced by buildings and homes as the city of Fresno expands northward. The hardpan provides a good foundation for construction. Capability unit IIIs–8 (17); range site 8; natural land type C13; Storie index rating 24.

San Joaquin loam, shallow, 3 to 9 percent slopes (SgB).—The profile of this soil is similar to that of San Joaquin loam, 0 to 3 percent slopes, but the subsoil is thinner. Depth to the hardpan ranges from 21 to 24 inches. This soil is mainly east of Clovis and occupies gently meandering swales incised in the terraces, beveled parts of old alluvial benches, and undulating areas of the terraces. Runoff is medium. In undulating areas, the runoff becomes sluggish in the drainage swales. The hazard of erosion is slight to moderate.

Included with this soil in mapping was a small area of a similar soil that has a fine sandy loam surface layer.

San Joaquin loam, shallow, 3 to 9 percent slopes, is used mainly for grazing or dryfarmed barley. Some small areas west of Pinedale are used for growing figs. The management for grazing and dryfarmed barley are similar to that for San Joaquin loam, 0 to 3 percent slopes. Some of this soil lies in tracts that likely will be used as homesites in the future. Capability unit IVe–3 (17); range site 8; natural land type C13; Storie index rating 21.

San Joaquin-Alamo complex, 3 to 9 percent slopes (ShB).—This complex consists of San Joaquin loam and Alamo clay so closely intermingled that it was not practical to separate them at the scale used in mapping. The complex is on a undulating part of a low terrace south of Granite Hill, near Orange Cove.

The San Joaquin soil is dominant and makes up 70 to 80 percent of the complex. The Alamo soil is fairly evenly distributed throughout the unit and occupies the bottoms of roughly circular depressions or irregularly shaped swales that have no external drainage. It comprises between 20 to 30 percent of the total acreage. The profiles of these soils are similar to those described as typical for the respective series.

Nearly all of the runoff from the San Joaquin soil collects in the swales occupied by the Alamo soil. The San Joaquin soil is gently sloping to moderately sloping; its hazard of erosion is slight to moderate.

The soils of this complex are difficult to irrigate. If sprinklers are used, the swales become flooded. Leveling does not completely alleviate the difficulty of irrigating. Where leveled, the soil material in the swales has slow internal drainage because of the buried Alamo soil. Unless a complete drainage system is installed, excess water accumulated in the swales can persist for long periods and limit deep rooting. Without drains, careful control of the amounts of irrigation water applied can minimize the difficulty. However, little can be done about excess water from storms in very wet years. Capability unit IVe–3 (17); range site not assigned; natural land types C13 and C14–1o; Storie index rating 25.

Sesame Series

The Sesame series consists of well-drained soils that formed in place from the weathering of granitic rock, principally quartz diorite. These soils are moderately deep to weathered rock. They have a dominantly sandy clay loam subsoil. The soils are mainly in the lower edges of the foothills. They are undulating to hilly, and their surface is smooth and rounded. Some of these soils are gently sloping and are in somewhat higher lying areas of the foothill valleys. Slopes are 3 to 30 percent. There are few rock outcrops.

The Sesame soils range in elevation from 500 to 2,000 feet. According to elevation, average annual rainfall ranges from 14 to 25 inches; average annual temperature from 62° to 59° F.; and the average growing season from 275 days along the edge of the foothills to 250 to 225 days in the higher locations. The natural vegetation is mainly annual grasses and forbs, but there are some open stands of hardwoods and some brush at the higher elevations.

In a typical profile, the surface layer is slightly acid, dark grayish brown and dark brown sandy loam about 10 inches thick. The subsoil is slightly acid or neutral, dark-brown sandy clay loam and sandy loam that grade into weathered quartz diorite at a depth of 30 inches. The quartz diorite has a high content of dark minerals.

The Sesame soils are frequently contiguous with the Vista and Fallbrook soils in the lower foothills and with many soils of the erosionally dissected terraces along the edge of the foothills. They are adjacent to the Auberry soils in higher areas. All of the Sesame soils have slopes of less than 30 percent, and more than 90 percent of these soils have slopes of less than 15 percent.

The Sesame soils are used mainly for grazing. Some areas are used for grain cut for hay or for dryfarmed barley. Some small areas are used for oranges. The location and depth of the soils make them suitable for citrus, but irrigation water is limited. Intermittent streams and occasional springs are the main sources of water in the area of these soils. Generally there is not enough water locally available for irrigated crops.

Representative profile on a northeasterly slope of about 5 percent in an undulating dryfarmed grain field at an elevation of 700 feet (about 3 miles E. of the town of Friant; 300 feet N., 50 feet W. of the junction of the road to Winchell Creek and Millerton Road in the NE¼SE¼ of sec. 10, T. 11 S., R. 21 E.):

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; massive or cloddy; hard to very hard when dry, friable when moist, nonsticky and nonplastic when wet; abundant very fine roots, few fine tubular pores; slightly acid (pH 6.4); abrupt, smooth lower boundary.

A3—6 to 10 inches, dark-brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) when moist; massive; very hard when dry, friable when moist, slightly sticky and nonplastic when wet; plentiful fine and very fine roots, few fine tubular pores, few thin clay films in pores; slightly acid (pH 6.4); abrupt, smooth lower boundary.

B21—10 to 22 inches, dark brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) when moist, weak, medium, subangular blocky structure; very hard when dry, friable to firm when moist, slightly sticky and slightly plastic when wet, roots and pores similar to those in A3 horizon; common thin clay films on ped faces, continuous thin clay films in pores; slightly acid (pH 6.5); clear, smooth lower boundary

B3—22 to 30 inches, dark-brown (7.5YR 4/4) sandy loam, dark brown (7.5YR 3/2) when moist; weak, medium, subangular blocky structure, very hard when dry, friable when moist, slightly sticky and slightly plastic when wet, few fine and very fine roots; few fine tubular pores; few thin clay films on ped faces, continuous thin clay films in pores; neutral (pH 6.8); clear, smooth lower boundary

C—30 inches +, brownish yellow (10YR 6/6), weathered, coarse-grained quartz diorite, yellowish brown (10YR 5/4) when moist; flecked with dark-gray and black minerals, rock fabric clearly visible showing many fine-grained autoliths, several feet to unweathered rock

The A horizon ranges from dark brown to dark grayish brown (10YR [illegible] 4/2). When this layer is moist, it ranges from dark grayish brown to dark brown or very dark brown (10YR 3/2, 4/2, 3/3; 7.5YR 2/2, 3/2). It is generally massive or cloddy, hard to very hard when dry. It is commonly slightly acid but is medium acid in places. The A horizon ranges from about 2 to 14 inches in thickness. It is thinner in areas affected by sheet erosion. Texture is sandy loam or loam.

The B horizon is dense and slowly permeable. It is brown to dark brown ([illegible], 4/4; 10YR [illegible]) when dry. When moist, it is dark brown, dark grayish brown (7.5YR 3/2, 3/3, 10YR 3/3, 3/2), and dark reddish brown in places (5YR 3/3, 3/4). Texture ranges from sandy clay loam to heavy sandy loam. The structure is generally subangular blocky or angular blocky and commonly weakly expressed. In places [illegible] the horizon is massive, and in other places [illegible] of structure [illegible]. The reaction is slightly acid to neutral. The thickness of the B horizon ranges from about 12 to 24 inches.

Sesame sandy loam, 3 to 9 percent slopes (SkB).—This soil has the profile described as typical for the series. The soil is mainly along the lower edge of the foothills in small areas. The surface is smooth, and the soil is undulating to gently rolling.

Permeability is moderately slow. Runoff is slow to medium. The available water holding capacity for plants is moderate to low. The erosion hazard is slight.

Included with this soil in some of the higher valleys south of the Kings River are similar soils that have a coarse sandy loam surface layer. In other places, similar soils that have a sandy clay subsoil are included. In addition, there are small included stringers of Hildreth clay in some of the drainage swales.

The principal use of this soil is for range. It is also used for dry pasture, dryfarmed barley, and grain cut for hay. Forage growth can be improved by fertilizing with nitrogen, phosphorus, and sulfur. In areas cultivated for dryfarming, tilling across the slope or on the contour helps to reduce erosion and increases moisture retention by slowing runoff. The surface layer tends to compact or puddle easily when wet. Capability unit IIIe-8 (18); range site 6; natural land type E1; Storie index rating 41.

Sesame loam, 3 to 9 percent slopes (SlB).—The profile of this soil is similar to that of Sesame sandy loam, 3 to 9 percent slopes. It is in many small areas on low knolls and foot slopes of steeper hills in the vicinities of Clarks Valley, Citrus Cove, Tivy Valley, Holland Creek, Round Mountain, and Academy. Its available moisture holding capacity is moderate to high.

Included with this soil in mapping were small areas of a similar soil that has a clay loam surface layer. Also included are other small areas of a similar soil that is nearly level. The included soil is on remnants of low knolls that are part of the foothills, but that have been nearly buried by surrounding alluvium.

The use and management of Sesame loam, 3 to 9 percent slopes, are similar to those of Sesame sandy loam, 3 to 9 percent slopes. Forage growth is somewhat better, and the soil tends to dry out somewhat more slowly in late spring. Some orange trees have been planted on this soil in Tivy Valley where irrigation water is available from shallow wells nearby. The soil lies within the thermal belt along the foothills and has good air drainage. Capability unit IIIe-8 (18); range site 6; natural land type E1; Storie index rating 43.

Sesame loam, 9 to 15 percent slopes (SlC).—The profile of this soil is similar to that of Sesame sandy loam, 3 to 9 percent slopes. It is on knolls and the lower slopes of hills near Tivy Valley, Citrus Cove, Clarks Valley, Holland Creek, Round Mountain, and Squaw Valley. It is strongly sloping or rolling. The hazard of erosion is slight to moderate. The available water holding capacity is moderate to high.

Included with this soil in mapping are several small areas of similar soils that are somewhat steeper, have a rocky surface, or have a clay loam surface layer.

Nearly all of the acreage of Sesame loam, 9 to 15 percent slopes, is used for grazing. Management is similar to that for Sesame sandy loam, 3 to 9 percent slopes, but somewhat greater care should be taken to avoid overgrazing. A small area in Tivy Valley is used for citrus. Water for irrigation is pumped from a shallow well in nearby valley alluvium. Irrigation water can be applied on steeper areas through gated pipe, in contour furrows, or by low-set sprinklers. The soil is in an area of relatively low frost hazard and has good air drainage. Capability unit IVe-8 (18); range site 6; natural land type E1; Storie index rating 36.

Sesame sandy loam, 9 to 15 percent slopes (SkC).—This soil is widely scattered in the foothills. Some areas are east of Friant, others are in Squaw Valley, and still others are south of White Deer Flat, at the higher elevations. It has a profile that is similar to that of Sesame sandy loam, 3 to 9 percent slopes. The erosion hazard is moderate.

Included with this soil east of Friant is a small area of a similar soil that is less than 20 inches to weathered rock.

Sesame sandy loam, 9 to 15 percent slopes, is used for grazing and dryfarmed barley or grain cut for hay. It is not favorably located for citrus plantings, because of the frost hazard.

Fertilizing with nitrogen, phosphorus, and sulfur improves forage growth. In some cases the increase

in production of forage has offset the need to rent additional range elsewhere for year-round grazing. Consequently, costs in handling livestock have been reduced. Overgrazing should be avoided. Capability unit IVe-8 (18); range site 6; natural land type E1; Storie index rating 36.

Sesame sandy loam, 15 to 30 percent slopes (SkD).—This hilly soil is near Owens Mountain and South of White Deer Flat. It has a profile that is similar to that of Sesame sandy loam, 3 to 9 percent slopes. Runoff is medium to rapid, and hazard of erosion is moderate to high.

The soil is used only for grazing. Its management is similar to that for Sesame sandy loam, 3 to 9 percent slopes. Greater care is needed, however, to avoid overgrazing. Capability unit VIe-1 (17, 18); range site 6; natural land type E1; Storie index rating 31.

Shaver Series

The Shaver series is made up of well-drained, coarse sandy loam soils that formed in material weathered in place from granitic rocks, mainly quartz diorite. [illegible] canyons and on northerly slopes in the vicinity of Miramonte and Pinehurst at elevations ranging from 3,200 to 3,900 feet. Slopes are 15 to 45 percent. The average annual precipitation ranges from 30 to 35 inches. Much of the precipitation falls as snow, which stays packed on the ground for longer periods of time than at comparable elevations elsewhere in the survey area. The average annual temperature ranges from 50° to 53° F., and the average growing season ranges from 150 to 175 days.

The natural vegetation consists of conifers, grasses, shrubs, and scattered hardwoods. Ponderosa pine and incense-cedar comprise the conifer cover. Grass forms a moderately dense cover in clearings and is made up chiefly of annuals. The shrubs are mainly wedgeleaf ceanothus, deerbrush, and some bear-clover. The hardwoods are black oak, blue oak, and some canyon live oak.

In a typical profile, the surface layer is slightly acid, dark grayish brown and grayish-brown coarse sandy loam about 14 inches thick. It is soft and has a high content of organic matter. The subsoil is medium acid, brown and pale-brown coarse sandy loam that is massive and soft and is about 46 inches thick. Deeply weathered parent rock is at a depth of 60 inches or more.

Water is obtained from small [illegible] springs, and shallow wells drilled into the weathered rock. The amount of water available is limited.

Representative profile in a sparsely timbered area of idle land under a vegetative cover of sparse annual grass, bear clover, ponderosa pine, and black oak, on an east-facing slope of a[illegible] of 3,320 feet (about [illegible] Pinehurst Ranger Station; fresh excavation in a cut bank of a turnout on State Highway No. 69 in SW¼NW¼ of sec. 35, T. 14 S., R. 27 E.):

O1—½ inch to 0, loose, dried litter of pine needles and leaves and twigs.

A11—0 to 6 inches, dark grayish brown (10YR 4/2) coarse sandy loam, very dark gray (10YR 3/1) when moist; strong, fine, crumb structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; plentiful very fine roots, few very fine tubular pores; slightly acid (pH 6.[illegible]); gradual, smooth lower boundary.

A12—6 to 14 inches, [illegible] (pH [illegible]); gradual [illegible] boundary.

B21—[illegible] to slightly hard when dry, very friable [illegible] nonsticky and nonplastic when wet; [illegible] boundary.

B22—36 to 48 inches, brown (10YR 5/3) coarse sandy loam, dark brown (10YR 4/3) when moist; massive, soft [illegible] very slightly sticky and nonplastic when wet; few fine roots, very few very fine tubular pores, many fine to very fine interstitial pores, thin clay [illegible] on many sand grains; medium acid (pH [illegible]); diffuse, smooth lower boundary.

B3—48 to 60 inches, pale brown (10YR 6/3) coarse sandy loam, dark brown (10YR 4/3) when moist; massive, soft to slightly hard when dry, very friable [illegible] when wet, [illegible]

C—[illegible] granitic rock fabric easily [illegible] easily excavated, fragments crush [illegible]

The A horizon is dark grayish brown or grayish brown (10YR 4/2, 5/2) but in places is dark gray (10YR 4/1). The darker colors generally occur in the A11 horizon. When moist, the A horizon ranges from very dark brown or very dark gray to dark grayish brown (10YR 2/2, 3/1, 3/2). The texture is commonly coarse sandy loam but is sandy loam in [illegible] though it varies in grade from place to place [illegible] and in others it has a mixture of crumb and gra[illegible] [illegible] but in places is as thin as 6 inches or as thick as 36 inches.

The B2 horizon is typically brown when dry (10YR 5/3; 7.5YR 5/4) but is yellowish brown (10YR 5/4) in some places. When moist, it is normally dark brow[illegible] places occasionally strong brown (10YR 3[illegible] 5/6); the lighter or brighter colors are in the lower parts of the horizon. The B2 horizon ranges from about 12 to 54 inches in thickness but is commonly 30 to 36 inches thick. The consistence is generally soft or slightly hard when dry [illegible] the B2 horizon is very slightly sticky when wet from thin clay films accumulated on mineral grains. The reaction is slightly acid to medium acid.

The B3 horizon above the weathered parent rock is typically pale brown (10YR 6/3) when dry and brown to [illegible] brown when moist (10YR 5/3, 4/3). The texture ranges from coarse sandy loam to loamy coarse sand. It is mass[illegible] and consistence and reaction are similar to those [illegible] horizon. The upper boundary of the weathered pa[illegible] is abrupt or very abrupt and wavy or irregular in places.

Shaver coarse sandy loam, 1[illegible] percent slopes (SmE).—This is the only Sh[illegible] mapped

in the survey area. It has the profile described as typical for the series. About 60 percent of the acreage has slopes of 30 to 45 percent; the rest has slopes of 15 to 30 percent. The depth of soil to weathered rock is more than 40 inches and, in places, is as much as 70 inches. Occasional outcrops occur along stream courses in the bottoms of small canyons or where this soil adjoins areas of Tollhouse soils or Rock land.

Runoff is medium to rapid. The moderately rapidly permeable subsoil and the weathered parent rock permit deep percolation of excess water. The available water holding capacity is moderate. The hazard of erosion, particularly for causing gullies, is high.

Included with this soil are some very small areas of Ahwahnee, Holland, or Sierra soils.

Shaver coarse sandy loam, 15 to 45 percent slopes, is used for grazing. Forage growth can be improved by fertilizing with nitrogen and phosphorus. Much of the acreage is used for recreational areas or country homesites. The soil supports timber of medium site value, but there is no commercial logging because of the limited amount of timber. Also, timbered areas are small and held principally for their value for recreational uses or homesites. Capability unit VIe–1 (22), range site 2; natural land type E1[1]; Storie index rating 34.

Sierra Series

The Sierra series consists of well-drained to somewhat excessively drained soils with a sandy clay loam to clay loam subsoil that formed in place from deep weathering of granitic rock. The parent rock is principally quartz diorite and has a fairly high proportion of dark-colored, iron-bearing minerals. These soils are gently rolling to very steep and mountainous. Slopes are 3 to 70 percent. Large outcrops of parent rock are common.

The soils are mainly in the southern part of the foothills in the vicinity of Sand Creek, Dunlap, and Miramonte. A few small areas lie north of the Kings River near Auberry and Tollhouse. The soils are at elevations of 2,000 to 4,000 feet. According to elevation, average annual precipitation ranges from 20 to 30 inches, and the average annual temperature ranges from 58° to 53° F. The growing season ranges from 150 to 200 days. The natural vegetation consists of trees, grass, and shrubs. The trees are commonly blue oak, interior live oak, and California buckeye. There are some canyon live oak, black oak, and oracle oak. The grass consists mainly of annuals, but there are a few perennials and many forbs. The common shrubs are wedgeleaf ceanothus, mariposa manzanita, and some yerba santa.

In a typical profile, the surface layer is neutral to slightly acid, grayish-brown sandy loam about 13 inches thick. The subsoil is medium acid, reddish-brown clay loam and brown sandy clay loam about 59 inches thick. It is underlain by deeply weathered quartz diorite at a depth of about 72 inches.

The principal use of the Sierra soils is for range. Water for domestic use, for livestock, and for local irrigation is obtained from springs, shallow wells in alluvial pockets or deeply weathered rock, a few small [illegible] streams [illegible] Mill Creek, and numerous intermittent streams. The intermittent streams are generally dammed to hold water for livestock.

Representative profile on the broad crest of a moderately steep ridge that [illegible] in a north-south direction, in an area recently cleared of a dense cover of wedgeleaf ceanothus and mariposa manzanita, now under a cover of annual grasses, forbs, tarweed, and sprouting yerba santa, at an elevation of 3,690 feet (about 2.4 miles, airline, SSE. of the Pinehurst Ranger Station on the W. side of Visalia Road in the SE¼ of sec. 35, T. 14 S., R. 27 E.):

A1—0 to [illegible] (10YR 5/2) when [illegible] sandy [illegible] boundary.

A12—[illegible] very fine and fine to [illegible] pH [illegible] gradual [illegible] boundary.

B2t—13 to 30 inches, reddish-brown (5YR 5/6) clay loam, reddish brown (2.5YR 4/4) when moist; moderate, coarse, blocky structure; many, moderate clay films on ped faces; color of the clay films is also reddish brown but has a slightly lower chroma when dry (5YR 5/4); very hard when dry, friable when moist, sticky and plastic when wet; few medium roots; common fine and very fine tubular pores coated with thin to moderately thick clay films; medium acid (pH 6.0); diffuse, smooth lower boundary.

B3t—30 to 72 inches, brown (7.5YR 5/4) sandy clay loam, reddish brown (5YR 4/3) when moist; weak, coarse, subangular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; few fine roots; few very fine tubular pores; common thin clay films on ped faces and in pores; more mica visible than in horizons above; medium acid (pH 5.6); abrupt, wavy lower boundary.

C—72 inches +, gray, well-weathered, medium granular quartz diorite; rock fabric clearly visible in place; readily excavated fragments crush to coarse sand or loamy coarse sand; many very fine and micro-size pores between mineral grains; many feet to unweathered rock.

In the foregoing profile, a thin litter of dried grass and parts of forbs overlies the A horizon.

The A horizon ranges from brown to dark grayish brown [illegible] or that of a broken fragment, is most commonly grayish [illegible] rubbed. When moist, the A horizon is dark brown, very dark grayish brown, or dark brown (10YR 2/2, 3/2, 3/3, 7.5YR 3/2). Texture ranges from sandy loam to coarse sandy loam. Structure is typically granular but weakens under excessive trampling by grazing animals. Reaction is neutral to slightly acid. The boundary between the A and B1 horizons is clear to gradual; in places there is a B1 horizon.

The B2t horizon is typically reddish brown (5YR 4/4, 5/4, 2.5YR 4/4) but is yellowish red (5YR 5/6) in places. In [illegible] matrix colors and reddish brown (5YR 5/4) clay film coatings. Moist colors are reddish brown to dark reddish brown (5YR

4/3, 4/4, 3/4, 2.5YR 4/4, 3/4) and in some places yellowish red (5YR 5/6, 4/6). The transitional B1 or B2 horizon is similar in color or is browner (7.5YR 4/4, 5/4). In places the B3 horizon is more yellow (7.5YR 6/6, 10YR 6/4) than is described as typical. Structure of the B2t horizon is commonly coarse blocky but is subangular blocky in places and ranges in grade from weak to strong. In places it is weakly prismatic and generally breaks readily to stronger blocky peds. Texture is sandy clay loam to clay loam. Reaction ranges from neutral to medium acid. The depth of soil to the weathered parent rock ranges from about 36 to 60 inches.

Sierra sandy loam, 15 to 30 percent slopes (SnD).—This hilly soil has the profile described as typical for the series. It is in the vicinity of Miramonte and Pinehurst. This soil has a smooth surface and is well drained. Runoff is medium to rapid after the surface layer is saturated. Permeability is moderately slow, and the hazard of erosion is high. The available water holding capacity is high.

Included with this soil in mapping were small areas of soils similar to the Auberry soils. Also included were small areas of similar soils that have a loam surface layer. These included areas are on the west side of Stony Flat and south of White Deer Flat.

Sierra sandy loam, 15 to 30 percent slopes, is used for range or for dry pasture. It is also part of a small watershed. Brushy areas of this soil provide some shelter and refuge for small wildlife. Deer graze some of the forage and browse on the shrubs. Forage production can be improved in quantity and palatability by fertilizing with nitrogen, phosphorus, and sulfur. In locations favorable for intensive management, this soil can be used for dry pasture. It is generally associated with steeper areas of a similar soil, and the tendency of grazing animals to feed more heavily in the less steep areas should be discouraged to avoid overgrazing. Capability unit VIe-1 (17, 18); range site 2; natural land type E1; Storie index rating 61.

Sierra very rocky sandy loam, 3 to 30 percent slopes (SoD).—The profile of this soil is similar to that of Sierra sandy loam, 15 to 30 percent slopes, but its surface is very rocky. Outcrops of parent rock occupy from 2 to 25 percent of the surface. The outcrops are subrounded, irregularly shaped masses of rock that stand out prominently; they are generally not low lying. They are commonly dull gray, but on the lichen-free surfaces near the ground, they have a rusty color. The hazard of erosion is slight to high. It is somewhat variable from place to place because of the rockiness.

A small area of similar soil, located northeast of Dunlap, was included with this soil in mapping. The soil is stony rather than rocky and has formed, in part, in eroded remnants of debris of schist and quartzite material from very steep areas east of Dunlap. There is very little difference between the soils that formed in the stony material and adjacent soils that formed in deeply weathered granitic rock and have some mixture of the stony material. Several steep ravines have been incised in the included areas.

The use and management of this soil are similar to those of Sierra sandy loam, 15 to 30 percent slopes, but the rockiness discourages management for dry pasture. The outcrops and brush offer protective sites for small wildlife. Converting the large brushy areas by controlled burning will increase the acreage that can be grazed. Capability unit VIs-1 (18); range site 2; natural land type E4; Storie index rating 36.

Sierra very rocky sandy loam, 30 to 45 percent slopes (SoE).—The profile of this soil is similar to that described as typical for the series, but rock outcrops occupy 2 to 25 percent of the surface and soil depth does not exceed 48 inches. The outcrops are subrounded, irregularly shaped rock masses that stand out prominently. This soil occupies steep ridges and hills. Some areas are located on the watersheds of Bull Creek and Sand Creek; others lie near Mitchell Peak and on the south shoulder of Burrough Mountain.

The natural drainage of this soil is somewhat excessive. Runoff is rapid. The hazard of erosion is high but varies from place to place depending on the outcrops. The available water holding capacity is moderate.

A small area of similar soil, located on a saddle southwest of Kerckhoff Lake, was included with this soil in mapping. The depth of this included soil is less than 24 inches.

The use of Sierra very rocky sandy loam, 30 to 45 percent slopes, is similar to that of Sierra very rocky sandy loam, 3 to 30 percent slopes. Forage growth is good where the density of shrubs is low. Fertilizing this soil from the ground is a questionable practice because the steep slopes and rocks make application difficult. Capability unit VIIs-8 (18); range site 2; natural land type E12; Storie index rating 16.

Sierra very rocky sandy loam, 45 to 70 percent slopes (SoF).—The profile of this soil is similar to that of Sierra sandy loam, 15 to 30 percent slopes, but rocks occupy 10 to 50 percent of the surface and the depth of soil is not more than about 40 inches. The soil occupies prominent ridges and very steep hills, mainly in the southern foothills.

The natural drainage is somewhat excessive. Runoff is rapid, and the erosion hazard is very high. The available water holding capacity is moderate.

This soil is used mainly for range. It also makes up important parts of many local watersheds, and its shrubby, rocky areas provide some refuge for wildlife. If the soil is not overgrown with shrubs, the amount of forage produced is fair to good. Production of forage is less in the very rocky areas, and the very steep slopes tend to reduce the grazing intensity. Better use of forage can be encouraged by making stock trails and selecting undergrazed places for salt licks. Fertilizing the range is not practical. Areas of this soil alone are not included in projects to convert the type of plant cover, but areas of this soil can be included with larger areas of brushy soils on less steep slopes. Capability unit VIIs-8 (18); range site 2; natural land type E12; Storie index rating 8.

Sierra sandy loam, 9 to 15 percent slopes (SnC).—This smooth, rolling soil occupies parts of broad drainage divides and small valleys. The profile of this soil is similar to that of Sierra sandy loam, 15 to 30 percent slopes. The soil is near Miramonte, Stony Flat, and Big Sandy Valley south of Auberry. Near Stony Flat a small area of a similar soil that is gently

sloping has been included. The erosion hazard is moderate. There is a greater likelihood of erosion in places where the soil is used for apple orchards than in places used for range.

Most of the acreage of this soil is used for grazing or for dry pasture. Fertilizing with nitrogen, phosphorus, and sulfur is practical. Where small dams have been built and water is available, some pasture is irrigated by sprinklers. Only a small area of the soil is used to grow apples. If erosion is kept under control, the soil is suited to this crop. The elevation provides cool weather that is needed for ripening apples. Supplemental water for some irrigation is desirable. Capability unit IVe-8 (18); range site 2; natural land type E1. Storie index rating 58.

Sierra sandy loam, 30 to 45 percent slopes (SnE)—This steep soil is in the foothills on hills and ridges that are smooth and rounded. It has a profile that is similar to that of Sierra sandy loam, 15 to 30 percent slopes. There are only a few outcrops of parent rock. The natural drainage is somewhat excessive. Runoff is rapid, and the hazard of erosion is high.

Included with this soil in mapping were small areas of similar soils having a loam surface layer. They are near Stony Flat and south of White Deer Flat. Some areas of the included soil south of White Deer Flat have slopes of more than 45 percent.

The use and management of Sierra sandy loam, 30 to 45 percent slopes, are similar to those of Sierra sandy loam, 15 to 30 percent slopes. This steeper soil is used only for range. It is not used for dry pasture. In many areas the forage production is limited by a semidense or dense cover of shrubs. Capability unit VIIe-1 (18); range site 2; natural land type E9; Storie index rating 20.

Sierra sandy loam, 45 to 70 percent slopes (SnF)—This very steep soil has a profile that is similar to that of Sierra sandy loam, 15 to 30 percent slopes. It occupies the sides of ridges and mountains in the upper foothills. It is in the general vicinity of Dunlap, on the upper watersheds of Sand Creek and Bull Creek, southeast of Pinehurst, and on the Deer Creek drainage north of the Kings River. Areas of this soil in which the depth of soil is greater than 48 inches are mainly confined to protected, north facing slopes.

The general drainage is somewhat excessive. Runoff is rapid, and the hazard of erosion is very high.

The use and management of this soil are similar to those of Sierra very rocky sandy loam, 45 to 70 percent slopes. Forage production is somewhat greater because there are no rock outcrops. Capability unit VIIe-1 (18); range site 2; natural land type E9; Storie index rating 14.

Sierra-Tollhouse-Rock land complex, 45 to 70 percent slopes (StF).—This mapping unit consists of Sierra sandy loam and Tollhouse gravelly coarse sandy loam and areas of Granitic rock land so intermingled that it is impractical to separate them at the scale used in mapping. This complex is on steep hills and canyon slopes. Generally, the Sierra soil is dominant, but the Tollhouse soil makes up somewhat more than 30 percent of the total acreage. The Tollhouse soil has a profile similar to that described for the Tollhouse series. The Sierra soil has a profile similar to that described as typical for the series. It is very deep and the surface layer is sandy loam to coarse sandy loam. Rock outcrops occur mainly in areas of the Tollhouse soil and Granitic rock land. This complex is west of Pinehurst and on the slopes of Wild Hog Canyon, south of Miramonte.

The natural drainage of the soils is somewhat excessive to excessive. Runoff is very rapid. The hazard of erosion is very high.

A semidense to dense cover of trees and shrubs grows on most of the acreage. Because of the dense cover and the very steep slopes, access is very difficult. The complex has only a limited use for browse. Good uses are as watersheds and for wildlife habitat. Fire trails have been cut through the dense cover in places. These trails also serve as stock trails and give more access to the browse for both livestock and deer. Capability unit VIIs-8 (18); range site 10; natural land types E9, E16, and E17; Storie index rating 11.

Swamp (Sw) consists of very poorly drained nearly level alluvial areas that occupy low positions on a flood plain. These areas are subject to ponding or have a local water table that is within only a few inches of the surface mainly from the collection of seepage water from the irrigation of nearby, higher lying areas. Most of the acreage of this miscellaneous land type occupies the broad, meandering flood distributary channels that lie near the base of the western bluffs that border the large secondary valley of the Kings River east of Sanger. The channels end back into bottom areas of the valley flood plain. The return of drainage water to the main river channel is slow. Before the flood control now provided by Pine Flat Dam, there was seasonal flooding by the Kings River.

Most of the acreage of Swamp is east of Sanger. A small area is also in a depression north of Kingsburg, which is part of an abandoned distributary of the Kings River.

Swamp is choked with willows, alders, vines, cattails and a wide variety of weeds, sedges, and perennial grasses. The surface microrelief is very irregular from numerous interlacing channels cut by past floods. The small ridges between channels provide relatively drier areas within the land type. Areas of soil that are accessible above the standing water resemble the soils of the Foster series and poorly drained soils that are similar to the Grangeville series. Texture varies from place to place; it ranges from sandy loam to loam.

Swamp provides browse and water for cattle grazing in adjoining pasture. It also provides refuge for waterfowl, other birds, and some small mammals. The standing water is a source of mosquitoes; areas of Swamp are routinely patrolled and sprayed to control the mosquitoes. If seepage water were controlled, areas of Swamp could be drained, leveled, and used for irrigated pasture. Capability unit Vw-2 (17); range site 11; natural land type B17; Storie index rating 5.

Temple Series

The Temple series consists of soils that formed un-

der poorly drained conditions from clay loam or loam granitic alluvium in the basin areas. The drainage has been improved through flood control and extensive pumping, which has lowered the regional water table. The soils now are nearly level and have a smooth surface, but their natural surface was gently undulating and cut by a few meandering sloughways.

Temple soils are located in an irregular, somewhat discontinuous band lying near the eastern edge of the basin areas from the Mendota Wildlife Management Area to the vicinity of Helm. From the vicinity of Helm, southeastward, to Burrel and Lanare, the soils occupy a large part of the basin areas. The soils are at elevations of 170 to 200 feet. The average annual precipitation is about 8 inches, and the average annual temperature is about 63° F. The average growing season is about 225 days. At present, nearly all of the Temple soils are cultivated and cropped. The natural vegetation before the drainage was altered consisted of many water-loving plants, such as tules, rushes, and sedges.

In a typical profile, the surface layer is mildly alkaline, dark-gray clay loam about 11 inches thick. The subsoil is mildly alkaline to moderately alkaline, mottled, calcareous, olive sandy clay loam and olive-gray clay loam about 20 inches thick. At a depth of 31 inches is a layer of pale-olive sandy loam that is underlain by light olive-gray loamy sand at a depth of 44 inches. At a depth of about 56 inches there is a pale-olive moderately alkaline loamy sand.

Irrigated Temple soils are used for field crops and permanent pasture. Irrigation water of generally good quality is obtained from wells in which the water table is between 50 to 100 feet. Water for some of these soils is also obtained from irrigation district canals. The source of this water is both from pumped ground water and from the Kings River.

Representative profile in a leveled, fallow field on the basin flood plain of the Fresno Slough, at an elevation of about 178 feet (about 3 miles, airline, SE. of the town of San Joaquin; 660 feet S. and 200 feet E. of the corner of Dinuba and Plumas Avenues in the NW¼NE¼ of sec. 32, T. 15 S., R. 17 E.):

Ap—0 to 6 inches, [illegible] (10YR 4/1) clay loam, very dark gray [illegible] when moist; [illegible] very slightly calcareous in parts; mildly alkaline (pH 7.4); abrupt, wavy lower boundary.

A12—6 to [illegible] (10YR 4/1) clay loam, very dark gray (10YR 3/1) when moist; weak, very coarse, subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; few fine roots; a few fragments of material from lower horizons mixed by deep chiseling; very slightly calcareous in parts; mildly alkaline [illegible] lower boundary.

B21gca—11 to 22 inches, olive (5Y 4/3) sandy clay loam, olive gray (5Y 4/2) when moist; weak, coarse, prismatic structure breaking readily to medium and coarse angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; common fine distinct mottles of dark gray; few fine roots; strongly calcareous, lime segregated in many fine soft masses; mildly alkaline (pH 7.8); clear, irregular lower boundary.

B22gca—22 to 31 inches, olive-gray (5Y 5/2) clay loam, olive gray (5Y 4/2) when moist; weak, coarse, prismatic structure breaking to medium and coarse angular blocky structure; very hard when dry, very firm when moist, sticky and plastic when wet; common, medium, faint mottles of light olive gray; [illegible] on ped faces; few fine [illegible] pH 8.0); abrupt, wavy lower boundary.

[illegible]—31 to 44 inches, [illegible] in common [illegible] soft [illegible] (pH 8. [illegible]); clear, wavy lower boundary.

IIC2g—44 to 56 inches, light olive-gray (5Y 6/2) loamy sand, olive gray (5Y 5/2) when moist; massive; soft to slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; very few, large, distinct mottles of yellowish brown; few vertical seams of bleached quartz grains following old root channels; slightly calcareous, lime segregated in fine seams; moderately alkaline (pH 8.4); abrupt, wavy lower boundary.

IIC3—[illegible] loamy sand, [illegible] in fine seams; moderately alkaline (pH 8.2).

The color of the A horizon ranges from dark gray to very dark gray (10YR 4/1, 3/1). The hue is commonly 10YR but [illegible] to 2.5Y. The structure of the A horizon is generally granular but in places is fine blocky. When moist, the horizon appears massive. The dry consistence ranges from slightly hard to very hard but is commonly hard. The reaction is neutral to mildly alkaline. The A horizon is calcareous in places, generally as a result of deep cultivation. Texture is loam, clay loam, or clay.

The B horizon [illegible] gray to olive brown or light olive brown. Moist colors are similar but in places darken to gray, olive gray or dark gray. The hue is [illegible] 2.5Y, the chroma is not less than 2.5. The structure is weak to moderate subangular or angular blocky. The B horizon is normally calcareous and is mildly alkaline to moderately alkaline. Lime may be disseminated but in many places is segregated in nodules, seams, or soft masses. Texture of the B horizon is clay loam or sandy clay loam.

The C horizon is commonly stratified, [illegible] mottled, and generally coarser textured than the A and B horizons.

Temple clay loam (0 to 2 percent slopes) (Td).—All of the acreage of this soil has been leveled and is under irrigation. It has the profile described as typical for the series. Leveling has produced a blotchy dark and light-color pattern in places on the surface where the olive-colored subsoil has been exposed. Occasional salt spot symbols within areas of this soil on the soil map indicate saline-alkali affected soil material left from the leveling of small knolls of Piper soils. The soil has improved drainage, but runoff is slow and the soil permeability is moderately slow. There is no hazard of erosion. The available water holding capacity is high.

Included with this soil in mapping was a minor area of a similar soil that has a surface layer of silty

clay loam. This included area is located near Tranquillity.

The crops commonly grown on Temple clay loam are cotton, grain sorghum, irrigated barley, alfalfa for seed, rice, sugar beets, and irrigated pasture. Alfalfa hay is seldom grown now because of the tendency of legumes to pick up and store toxic amounts of molybdenum from alkaline basin soils. Nitrogen is commonly used to fertilize these crops. In some cases phosphorus is also added. A good tilth is fairly easily obtained without heavy equipment. The high available water holding capacity permits fairly long periods between irrigations. Capability unit I-1 (17, 18); range site not assigned; natural land type B1; Storie index rating 81.

Temple clay (0 to 2 percent slopes) (Tq).—The profile of this soil is similar to that of Temple clay loam, but it has a clay surface layer about 18 inches thick. The clay surface layer is the result either of alluvial stratification in a limited area or of land leveling. The soil is in small areas between Helm and Tranquillity. Nearly all the areas are adjacent to, or within, larger areas of fine-textured Merced soils that have been leveled. The subsoil is an olive or olive-gray clay loam or sandy clay loam.

Included with this soil in mapping were some areas in which the Temple soil overlies Merced clay at a depth of 3 to 4 feet. Also included are small areas of a similar soil that is slightly saline. Areas where the surface layer is silty clay or sandy clay are also included.

The use and management of Temple clay are similar to those of Merced clay, with which this soil is associated. The surface layer of Temple clay is not so easily cultivated as that of Temple clay loam, and heavier machinery is commonly used. Capability unit IIs-5 (17); range site not assigned; natural land type B3; Storie index rating 57.

Temple clay loam, saline (0 to 2 percent slopes) (To).—The profile of this soil is similar to that of Temple clay loam but it contains slight accumulations of salts. Generally, the salts are in the subsoil and in the underlying material. Some areas northeast of Tranquillity have slight salt accumulation in the surface layer. This soil is in small areas mainly between Helm and the Mendota Wildlife Management Area.

Included with this soil are two small areas of a similar soil that is moderately saline. These included areas are southeast of Burrel; one is one-half mile east of Bender Union Elementary School, and the other is one-half mile west of the school.

The crops grown on Temple clay loam, saline, are similar to those grown on Temple clay loam. The salinity causes a slight reduction in growth. Continued application of excess irrigation water will slowly flush the salts below the root zone of most crops. Capability unit IIs-6 (17); range site not assigned; natural land type B1-2s; Storie index rating 65.

Temple clay loam, saline-alkali (0 to 2 percent slopes) (Tl).—The profile of this soil is similar to that of Temple clay loam but it has a strongly alkaline to very strongly alkaline subsoil that is also at least slightly saline. The surface layer is free of excess salts or excess salts and alkali. The soil is mainly southeast of Burrel. A small area lies north of Tranquillity.

Cotton, irrigated pasture, and grain sorghum are the principal crops grown on this soil. Shallow-rooted plants are not badly affected by the excess salts and alkali, but deeper rooted crops grow poorly. The general management of this soil is similar to that of Temple clay loam. This soil can be improved slowly by plowing gypsum deep into the soil and leaching it with excess amounts of water. This can be scheduled as a part of irrigation prior to planting. Capability unit IIs-6 (17); range site not assigned; natural land type B1-2s; Storie index rating 61.

Temple loam (0 to 2 percent slopes) (Ta).—A more friable surface layer of loam that is about 15 inches thick, distinguishes this soil from Temple clay loam. This soil is between Tranquillity and San Joaquin and between Helm and Lanare. Most of the acreage is located southeast of Helm. This soil is in very slightly higher positions than the Merced soils or the somewhat finer textured soils of the Temple series.

Small areas of a similar soil having a silt loam surface layer were included with this soil in mapping. In places this included soil overlies Merced clay at a depth of more than 4 feet. East of San Joaquin, a small area of an included soil overlies a light gray, compact, silty substratum at a depth of about 3 feet.

Most of the acreage of Temple loam is planted to cotton. The use and management of this soil are similar to those of Temple clay loam. Seedbed preparation is easier because of the more friable surface layer. Capability unit I-1 (17, 18); range site not assigned; natural land type B1; Storie index rating 95.

Temple loam, saline (0 to 2 percent slopes) (Tb).—This soil has a profile that is similar to that of Temple clay loam but has a loam surface layer and contains excess accumulations of salts. The salts are either distributed throughout the profile or are concentrated in the subsoil and underlying material. This soil is in the vicinities of Tranquillity, San Joaquin, and Lanare.

This mapping unit consists of a large area of Temple loam that has a slight accumulation of salts, and another somewhat smaller area of Temple loam that has a moderate accumulation of salts.

Temple loam, saline, is used for cotton, corn, grain sorghum, and irrigated pasture. The best growth is obtained where the salt accumulation is deepest in the profile. Flushing the soil with excess amounts of irrigation water will slowly leach the salts downward and improve growth. Capability unit IIs-6 (17); range site not assigned; natural land type B1-2s; Storie index rating 67.

Temple loam, saline-alkali (0 to 2 percent slopes) (Tc).—This soil has a profile that is similar to that of Temple clay loam. The subsoil and underlying material of this soil are strongly alkaline or very strongly alkaline and at least slightly saline. In most areas the surface layer is saline-alkali free. In the remaining areas, one-third to two-thirds of the surface layer is affected. Most of this soil is located in the vicinity of

Lanare and Burrel. Smaller areas are near Helm and San Joaquin.

This soil is used for cotton, irrigated pasture, and grain sorghum. Vegetative growth is not vigorous on this soil. Irrigated pasture does fairly well, particularly in those areas having a saline-alkaline free surface layer. Through continued treatment with gypsum and leaching with excess amounts of irrigation water, this soil can be improved slowly. The moderately slow permeability of the subsoil prevents quick reclamation. Capability unit IIs-6 (17); range site not assigned; natural land type R1-2s; Storie index rating 57.

Terrace escarpments (ThF) consists of bluffs that border the secondary valleys of the Kings River and the San Joaquin River and steep terrace fronts near these incised river valleys. Areas of this miscellaneous land type range from about 100 to 300 feet in width and in many places are many miles long. Their pattern is wavy. The escarpments are mainly steep to very steep. In places, however, they are extremely steep and have outcrops of hardpan or of older, softly consolidated alluvium.

The soil material in Terrace escarpments is variable. The differences depend upon the kinds of materials exposed in the terrace fronts and the degree of colluvial mixing that has occurred downslope. In the relatively stable places, the soil material is similar to that in soils of the Pollasky series. Texture ranges from sandy loam to loam. The vegetation is annual grasses and forbs. In places there are a few oaks and cottonwoods.

The general drainage is somewhat excessive. Runoff is rapid, and the hazard of erosion is high. In places, deep gullies have been cut into the escarpment face, and small, strongly sloping alluvial fans have formed at the base of the slope. The available water holding capacity of the soil material is generally very low.

This land type is not arable, but places accessible to livestock are used for grazing. In some places stepped excavations have been made along the bluffs to provide lots for homes. Capability unit VIIIe-1 (17, 18); range site not assigned; natural land type C17; Storie index rating 10.

Tivy Series

The Tivy series consists of well-drained to somewhat excessively drained loam soils that formed in upland areas from the weathering of gabbro-diorite rocks or metamorphic basic volcanic rocks. The soils are shallow or moderately deep to weathered rock. They are gently sloping to very steep, and their surface is undulating. They are on ridges and hills in the lower foothills. Slopes are 3 to 70 percent. Rock outcrops occupy about one-third of the area of Tivy soils.

Most of the acreage of these soils is located near Round Mountain. Some areas are south and west of Humphreys Station, and others are scattered on the Hughes Creek drainage near Pine Flat Dam. South of the Kings River, areas of these soils are widely scattered. Some areas are on parts of the foothill outliers, such as Jesse Morrow, Campbell, and Smith Mountains. Others are in warmer, drier areas in the general vicinity of Squaw Valley and Wonder Valley. The soils are at elevations of 500 to 2,000 feet. According to elevation, the average annual precipitation ranges from 14 to 20 inches, and the average annual temperature ranges from 62° to 59° F. The average frost-free season lasts about 200 to 250 days. The natural vegetation consists mainly of annual grasses and forbs. Scattered blue oak, interior live oak, wedgeleaf ceanothus, and mariposa manzanita invade the cover of grass at the higher elevations and also grow on some of the lower, protected slopes.

In a typical profile, the surface layer is slightly acid, grayish-brown loam about 12 inches thick. The subsoil is slightly acid, brown heavy loam about 14 inches thick. It overlies weathered parent rock at a depth of 26 inches. There are angular pebbles of parent rock throughout the profile.

The Tivy soils are used almost entirely for grazing. Shallowness and the low available moisture holding capacity make the soils unsuitable for dryfarming. Water is limited; the main sources are intermittent streams and occasional shallow wells in the weathered rock. In some areas water is obtained from wells in nearby pockets of alluvium along small creeks. Small earthen dams on the intermittent streams are constructed to store water for livestock. Reliable sources of irrigation water are not available locally.

Representative profile at a freshly exposed bank of an access road crossing a sloping spur ridge in range where slopes are 15 to 30 percent, under annual grasses and forbs and an open stand of blue oak, interior live oak, and a few shrubs of mariposa manzanita, at an elevation of 1,[illegible] feet (about three-fourths mile N. of Squaw Valley Ranger Station, California Division of Forestry, at the N¼ corner, sec. 35, T. 13 S., R. 25 E.)

A11—0 to 2 inches, grayish-brown (2.5Y 5/2) loam, very dark gray (10YR 3/1) when moist; weak, medium to fine, granular structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; abundant fine grass roots; common very fine tubular pores, many very fine interstitial pores; many angular pebbles of parent rock; slightly acid (pH 6.1); abrupt, wavy lower boundary.

A12—2 to 12 inches, grayish-brown (2.5Y 5/2) loam, very dark grayish brown (10YR 3/2) when moist; massive; hard when dry, friable when moist, nonsticky and nonplastic when wet; common fine grass roots; common fine and very fine tubular pores, many very fine interstitial pores; many angular pebbles of parent rock, some of which are partially weathered; slightly acid (pH 6.1); clear, wavy lower boundary.

B2t—12 to 26 inches, brown (10YR 5/3) heavy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; many medium and fine tubular pores; few to common thin clay films on ped faces and as coatings in the pores; some angular pebbles of parent rock; slightly acid (pH 6.5); clear, irregular lower boundary.

C—26 inches +, mostly gray to light gray, variably weathered and broken hornblende schist, some yellowish streaks; rock fabric clearly visible in weathered parts; joint planes nearly vertical, some dark-brown clay coatings on fracture planes.

in the upper part, a few roots penetrate along these breaks; several feet to unweathered rock.

The soil described in the foregoing profile is covered with thin litter consisting of partly decomposed grasses and forbs.

The depth of soil to the weathered parent rock is variable within short distances; it ranges from about 10 to 30 inches. The A horizon ranges from brown to dark brown or grayish brown (10YR 5/3, 4/3, 5/2, 2.5Y 5/2) when dry and from dark gray to very dark grayish brown or very dark gray (10YR 4/1, 3/3, 3/2, 3/1) when moist. The generally dark color is influenced by the relatively high proportion of dark mineral fragments in the sand fraction of the soil. The A12 horizon is generally massive, and the consistence is hard when dry. However, the A11 horizon is thin and has a granular structure in areas not trampled by grazing animals. The reaction of the A horizon is [illegible] neutral to slightly acid [illegible] in places [illegible].

The B horizon is commonly dark brown or brown (10YR 4/3, 5/3) when dry and dark brown or very dark grayish brown (10YR [illegible]) when moist. Texture ranges from loam to clay loam or sandy clay loam. The B horizon is massive or has weak to [illegible] blocky structure. The reaction is neutral to slightly acid.

The C horizon of weathered parent rock ranges from several inches to several feet in thickness. It grades into unweathered rock.

Tivy loam, 9 to 30 percent slopes (TkD).—This soil has the profile described as typical for the series. Areas of this soil are rolling or hilly. The surface layer is medium acid in places, particularly at higher elevations where the soil is adjacent to the Tretten soils. In places the subsoil has a reddish tint.

The soil is generally well drained. Runoff is medium to rapid, permeability is moderate, and the hazard of erosion is moderate to high. The available water holding capacity is low.

In some swale positions small areas of Hildreth clay were included in mapping. Along small drainageways, narrow areas of Honcut and Los Robles soils were also included.

Tivy loam, 9 to 30 percent slopes, is used only for range and dry pasture. It is generally too shallow for successful dryfarming. At the lower edge of the foothills, the more gently sloping areas are adapted to pasture irrigated from sprinklers if water can be obtained from wells in nearby parts of the Valley. Brush presents no problem for range management. Nitrogen fertilizers improve the normally fair to good forage production if there is adequate moisture. The value of phosphorus or sulfur fertilizers is uncertain. Capability unit IVe–8 (18); range site 5; natural land type E5; Storie index rating 36.

Tivy loam, 3 to 9 percent slopes (TkB).—The profile of this soil is similar to that of Tivy loam, 9 to 30 percent slopes. This gently rolling soil occurs as low islandlike knolls surrounded by valley alluvial soils. It is also on gentle foot slopes of hills and ridges. The soil is in many small areas near Watts Valley, Tivy Valley, and Clarks Valley. It also is on the lower watershed of Holland Creek. The soil is well drained. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

Included with this soil in mapping were small areas of similar soils that have a fine sandy loam or clay loam surface layer.

The use and management of Tivy loam, 3 to 9 percent slopes, are similar to those of Tivy loam, 9 to 30 percent slopes. Because of their location, some minor areas of this Tivy soil have been included with other deeper, more extensive soils in fields used for dryfarmed barley. Other small areas are near sources of water in the San Joaquin Valley and have been used for irrigated pasture with fair results. If the soil is fertilized and sprinkled, good to very good growth of forage is obtained. The soil should be tilled across the slopes to minimize erosion. Capability unit IIIe–8 (18); range site 5; natural land type E5; Storie index rating 41.

Tivy loam, 30 to 45 percent slopes (TkE).—This steep soil is on hills and the sides of ridges. It has a profile that is similar to that of Tivy loam, 9 to 30 percent slopes. It is near Tivy Mountain, east of Round Mountain, on part of Hughes Creek drainage, and south and west of Humphreys Station. On the more prominent ridges or mountains in the lower foothills, the soil occupies the drier and warmer aspects. The natural drainage is somewhat excessive. Runoff is rapid, and the erosion hazard is high.

Small areas of similar soils that have a clay loam, stony clay loam, or fine sandy loam surface layer have been included with this soil in mapping. The area of clay loam is near the canyon mouth of the Kings River, and that of stony clay loam is near the mouth of Little Dry Creek.

The use and management of Tivy loam, 30 to 45 percent slopes, are similar to those of Tivy loam, 9 to 30 percent slopes. However, few areas of this soil are suitable for dry pasture. Capability unit VIe–41 (18); range site 5; natural land type E13; Storie index rating 18.

Tivy loam, 45 to 70 percent slopes (TkF).—This very steep soil occupies the slopes of ridges or mountain sides on Tivy Mountain. It is also on parts of the Hughes Creek drainage and on ridges southwest of Humphreys Station. It has a profile that is similar to that of Tivy loam, 9 to 30 percent slopes. The natural drainage is somewhat excessive. Runoff is very rapid, and the erosion hazard is high.

Included with this soil in mapping was a small area of similar soil that has a fine sandy loam surface layer. Also included, on the north slopes of a prominent hill west of Tivy Mountain, was a small area having a clay loam surface layer.

Tivy loam, 45 to 70 percent slopes, is used only for range. The very steep slopes, however, reduce the grazing intensity. Grass fires are more likely than overgrazing to deplete the plant cover and to increase the erosion hazard. Development of stock trails and planned location of salt blocks improve the use of forage. The soil also makes up a part of small watersheds. Capability unit VIIe–4 (18); range site 5; natural land type E13; Storie index rating 8.

Tivy very rocky loam, 3 to 30 percent slopes (TlD).—The profile of this undulating to hilly soil is similar to that of Tivy loam, 9 to 30 percent slopes, but there are many outcrops of parent rock scattered over the surface. These outcrops occupy from 2

[illegible] percent of the surface [illegible] soil. The outcrops are angular or subangular, are dark colored, and range from about 1 to 5 feet in diameter. They generally are not more than 3 or 4 feet above the surface. Light-colored fragments or exposures of aplitic dikes or vein rocks appear in places. The soil [illegible] Valley and Clark Valley, on Smith Mountain, [illegible] Granite Hill, on and near Round Mountain, and southwest of Academy. Runoff is slow to rapid, and the hazard of erosion is slight to high. Because of the rockiness, however, runoff and erosion hazard vary locally.

Included with this soil in mapping were small areas of a similar soil on which more than 25 percent of the surface is occupied by outcrops. Also included were small areas having a clay loam or sandy clay loam surface layer.

Grazing is the main use of Tivy very rocky loam, 3 to 30 percent slopes. Cultivation is impractical because of the outcrops. The management of this soil for range is similar to that for Tivy loam, 9 to 30 percent slopes. The outcrops provide some refuge sites for small wildlife. Capability unit VIs-8 (18); range site 5; natural land type E8; Storie index rating [illegible].

Tivy very rocky loam, 30 to 70 percent slopes (TtF).—This soil has a profile that is similar to that of the Tivy loam, 9 to 30 percent slopes. Outcrops occupy 10 to 50 percent of the surface of areas mapped as this soil. The outcrops are dark colored and are about 1 to 5 feet in diameter. They are generally not more than 3 or 4 feet high. This steep to very steep soil is on prominent ridges and hills, commonly [illegible] places that are warm and dry. Most of the acreage is on Smith Mountain, Jesse Morrow Mountain, Tivy Mountain, Bald Mountain, Granite Hill, and in the vicinity of Piedra and Humphreys Station.

The natural drainage is somewhat excessive. Runoff [illegible] high to very high. The rockiness causes some local variations in runoff and the erosion hazard.

Included with this soil in mapping were small areas of similar soils that are gullied. Also included were small areas where the surface layer is sandy loam or clay loam.

Tivy very rocky loam, 30 to 70 percent slopes, is used for range and also makes up the upper parts of small watersheds. The rock outcrops provide some refuge and nesting sites for wildlife. The forage produced by this soil is significantly less than that produced by similar nonrocky soils. Fertilizing this soil from the ground, by mechanical means, is generally not practical. Developing stock trails and planned location of salt blocks can increase the use of forage on the steeper slopes. Capability unit VIIs-8 (18); range site 10; natural land type E16; Storie index rating 8.

Tollhouse Series

The Tollhouse series consists of shallow, excessively drained gravelly coarse sandy loams that formed in place from the weathering of quartz diorite rocks. These soils are steep and very steep; they occupy canyons, old fault scarps, and rocky hilltops. They are in the upper part of the foothills. Slopes are 30 to 70 percent.

These soils are distributed in places along the canyon of the San Joaquin River, on Black Mountain and Big Sandy Bluffs, and in the vicinity of Tollhouse. South of the Kings River, the soils are near the communities of Dunlap, Miramonte, and Pinehurst. In many of these locations the soils occur closely with the Ahwahnee, Auberry, and Sierra soils.

The Tollhouse soils are mainly at elevations above 2,000 feet, and their elevation ranges to about 3,500 feet. Some areas, however, are at lower elevations in deep canyons. According to elevation, the average annual precipitation ranges from 20 to 35 inches and the average annual temperature from 59° to 56° F. Snow may fall at the higher elevations, but it does not usually cover the surface for long. The chaparral cover is commonly made up of wedgeleaf ceanothus, chaparral whitethorn, mariposa manzanita, mountain-mahogany, and California-laurel. Also, there are some blue oak, interior live oak, canyon live oak, and Digger pine north of the Kings River. Some areas have grassy openings in the woody cover.

In a typical profile, the surface layer is slightly acid, dark grayish-brown gravelly coarse sandy loam that is loose and about 18 inches thick. It is medium acid in the lower 7 inches. This layer abruptly overlies physically weathered quartz diorite. Many pebbles of the parent rock are throughout the profile.

The shrubs on the Tollhouse soils provide some browse for grazing animals, but the main uses of these soils are as watersheds and as refuge areas for wildlife.

Representative profile in a fireguard strip on the east side of Jose Basin Road, which traverses a canyon face where slopes are more than 50 percent; under a cover of some annual grasses, forbs, and scattered shrub sprouts (natural cover before clearing was a semidense stand of trees and chaparral), at an elevation of 2,700 feet (about 1¼ miles E. of the survey area boundary, 2¾ miles, airline, NE. of Auberry near the center of SW¼ of sec. 34, T. 9 S., R. 23 E.):

A11—0 to 11 inches, dark grayish-brown (10YR 4/2) gravelly coarse sandy loam, very dark brown (10YR [illegible] crumb structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; plentiful fine roots, few medium roots, many pebbles of [illegible] rock; slightly acid (pH 6.3); clear, wavy lower boundary.

A12—11 to 18 inches, dark grayish-brown (10YR 4/2) gravelly coarse sandy loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular to crumb structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; few fine and medium roots; about 30 percent pebbles of parent rock; medium acid (pH 6.0); abrupt, irregular lower boundary.

[illegible] brown to white [illegible] physically weathered quartz diorite, rock fabric clearly visible, can be broken apart and crushed to [illegible] coarse sand; undisturbed material has many [illegible]

Thin, scattered litter consisting of dried leaves of grasses and shrubs covers the soil described in the foregoing profile.

The A11 horizon ranges from dark grayish brown to very dark grayish brown or dark gray (10YR 4/2, 3/2, 4/1) when dry. When moist, it is very dark brown to very dark grayish brown (10YR 2/2, 3/2). The darker colors are associated with denser cover of shrubs and higher content of organic matter. The color of the A12 horizon is generally the same as that of the A11, but in places the A12 horizon has a dry color of grayish brown (10YR 5/2) in deeper areas. Texture ranges from gravelly coarse sandy loam to gravelly loamy coarse sand, and there are 15 to 30 percent of fine gravel or coarser fragments. Structure ranges from granular to crumb, or in places the horizon [illegible] Areas of crumb [illegible]

Tollhouse extremely rocky coarse sandy loam, 30 to 70 percent slopes (TmF).—This is the only Tollhouse soil mapped in the survey area. It has the profile described as typical for the series. About 75 percent of the acreage of this soil has slopes of more than 45 percent. Rocks occupy from 2 to 50 percent of the surface. On about two-thirds of the acreage mapped as this soil, from 25 to 50 percent of the surface is rock outcrops. In some places the rock outcrops are above the brush cover, but most are obscured from view. They range from about 1 foot to 10 feet in diameter, [illegible] mally well covered [illegible]

[illegible] have slopes of less than 30 percent. Also included were many small areas [illegible] smooth rounded rocks that have few cracks. Small [illegible] soils were also included.

The rockiness, steep and very steep slopes, shallow depth of soil, and the normal shrubby cover preclude the use of this soil for range. Where small areas of the soil are associated with other soils used for range, some incidental browse is obtained from the shrubs. The best use of this soil is for watersheds. The rock outcrops and shrubs provide refuge for wildlife of the foothills. Because of the very low available water holding capacity and the high and very high erosion hazard, it is doubtful that the value for watershed could be improved by removing the brush. Opening narrow avenues in the brush increases the accessibility of browse for deer and for livestock. Capability unit VIIIs-8 (18); range site not assigned; natural land type E16; Storie index rating 8.

Toomes Series

The Toomes series consists of shallow, excessively drained extremely cobbly loam soils that formed from hardened mudflows of basaltic material. The soils are steep to very steep; they skirt several of the basaltic mesas in the vicinity of Millerton Lake and the town of Auberry. Slopes are 30 to 70 percent. The slopes start just below the cliffs of columnar basalt fringing the mesas and sweep downward to merge with the more gently sloping areas carved from the underlying granitic rock.

The soils are at elevations of 800 to 2,200 feet. The average annual precipitation ranges from 14 to 22 inches, the average annual temperature from 62° to 58° F., and the average frost-free season from 225 to 250 days. The natural vegetation consists mainly of annual grasses and forbs, and there are some mosses. [illegible] lupine, also grow on these soils, along with some Digger pine and blue oak. North-facing slopes support a more dense cover of woody vegetation.

In a typical profile, the surface layer is slightly acid and neutral, brown extremely cobbly loam about 5 inches thick. This layer is abruptly underlain by dark-brown, very slightly weathered and unweathered, angular basaltic cobblestones and stones that are imbedded in dense mudflow material 6 to 8 feet thick.

The Toomes soils are used only for range. There are no reliable sources of water within areas of these soils. During the rainy season, runoff water from the mesas above runs down the steep slopes in rills and gullies for limited periods following a storm. Some seeps occur along lower lying areas of these soils.

Representative profile on a south-facing slope of 50 percent, at an elevation of about 1,750 feet, under a cover of annual grasses, forbs, and some moss (about 3 miles airline W. of the town of Auberry on the S. side of Squaw Leap near the E½ corner of NW¼ of sec. 14, T. 10 S., R. 22 E.):

A11—0 to 2 inches, brown (10YR 5/3) extremely cobbly [illegible], dark brown (7.5YR 3/2) when moist; [illegible] very fine to medium, granular structure; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; abundant very fine and micro-size roots; slightly acid (pH 6.4); abrupt, smooth lower boundary.

A12—2 to 5 inches, brown (10YR 5/[illegible]) [illegible] cobbly loam, dark brown [illegible] moist, [illegible] abundant [illegible] ary.

R—5 inches +, dark-brown, very slightly weathered and unweathered, angular basaltic cobblestones and stones that are imbedded in unweathered, very hard, dense mudflow material 6 to 8 feet thick, underlain by deeply weathered granitic rock.

Covering the surface of the soil described in the foregoing profile is a thin, discontinuous litter of dried grass parts.

The A horizon ranges in thickness from about 3 to 12 inches. The color is commonly brown (10YR 5/3; 7.5YR 5/4) but is grayish brown in some places on north slopes (10YR 5/2). Moist colors range from very dark grayish brown to brown to dark brown (10YR 3/2; 7.5YR 3/2, 3/4). The lower horizon is generally associated with the upper part of the A horizon. The A11 horizon generally has granular or subangular blocky structure, and the A12 horizon is normally massive. The reaction is neutral or slightly acid. Where moss grows, the surface of the soil has a pH of about 6.0. At a depth of 2 inches, the pH is about 6.5. From 30 to 60 percent of the soil, by volume, consists of stones and cobblestones.

Toomes extremely cobbly loam, 30 to 70 percent slopes (TnF).—This is the only soil of the Toomes series mapped in this survey area. It has the profile described as typical for the series. It is steep to very steep and is located on slopes below the volcanic table lands in the foothills between Friant and Auberry. Most areas of this soil face the south and have slopes of more than 45 percent. The surface is cut by numerous shallow, healed gullies and some deep, active gullies that have vertical sidewalls.

The thin surface layer is moderately permeable, but the underlying material is impermeable. Runoff is rapid to very rapid, and the hazard of erosion is high to very high. The available water holding capacity is very low.

The soil has limited use for grazing. Livestock tend to undergraze available forage because of the steep and very steep slopes. This is particularly true in the latter part of the grazing season when the soil has dried up and footing is difficult. Because of its shallowness and south-facing slopes, this soil is among the first to dry out in the spring. Fertilization is not practical. Capability unit VIIs-7 (17, 18); range site 10; natural land type E16; Storie index rating 4.

Trabuco Series

The Trabuco series consists of moderately deep to deep, well-drained to somewhat excessively drained soils that have a dominantly clay subsoil. These soils formed in place on well-weathered basic igneous rocks and metamorphic basic volcanic rocks. These rocks include gabbrodiorite and hornblende schist. The soils are rolling to very steep and occur in the upper foothills. Slopes are 9 to 70 percent. About three-quarters of the acreage of Trabuco soils in this survey area have slopes of more than 45 percent. Of this acreage, more than half is occupied by outcrops of parent rock. Most of the soils having slopes of less than 45 percent are free of rock outcrops.

The soils range in elevation from 1,500 feet in protected canyons to about 3,500 feet on some prominent hills and ridges. According to elevation, the average annual precipitation ranges from 20 to 25 inches and the average annual temperature ranges from 59° to 55° F. The frost-free season lasts from about 150 to 200 days. The natural vegetation consists of a semiopen to a semidense cover of trees, grass, and shrubs. The prinicipal trees are blue oak and interior live oak; the grass cover is composed mainly of annuals; the principal shrubs are mariposa manzanita, wedgeleaf ceanothus, and poison-oak.

In a typical profile, the surface layer is slightly acid and neutral, brown loam about 10 inches thick. The subsoil is dark reddish-brown light clay and reddish-brown sandy clay loam. This layer is neutral and grades into well-weathered parent rock at a depth of about 30 inches.

Trabuco soils are used for range. Water for livestock comes mainly from small, intermittent streams and a few springs.

Representative profile on a very steep north-facing slope under a semidense cover of blue oak, interior live oak, mariposa manzanita, and poison-oak, as well as annual grasses and forbs in open areas, at an elevation of 2,250 feet (E. of Squaw Valley on the S. side of Ruth Hill Road in the NE1/4NE1/4 of sec. 12, T. 14 S., R. 25 E.):

O1—1 inch to 0, litter of grass and shrub cover.

A11—0 to 4 inches, brown (10YR 5/3) loam, dark brown (7.5YR 3/2) when moist; strong, fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant fine and very fine roots, few medium roots; slightly acid (pH 6.3); abrupt, wavy lower boundary.

A12—4 to 10 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 3/2) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant fine and very fine roots, few medium roots; common fine tubular pores; "salt and pepper" variegation in lower part of horizon; neutral (pH 6.7); abrupt, wavy lower boundary.

B2t—10 to 24 inches, dark reddish-brown (2.5YR 3/4) light clay, dark red (2.5YR 3/6) when moist; strong, coarse, angular blocky structure; very hard when dry, firm when moist, slightly sticky and plastic when wet; few fine roots, common medium roots; few fine tubular pores; many thin clay films on ped faces and as pore linings; neutral (pH 7.0); abrupt, irregular lower boundary.

B3t—24 to 30 inches, reddish brown (5YR 4/3) sandy clay loam, dark reddish brown (5YR 3/4) when moist; weak, coarse, angular blocky structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine tubular pores; few to common thin clay films on ped faces and as pore linings; neutral (pH 7.0); abrupt, irregular lower boundary.

C—30 inches +, varied dark-gray to black, well-weathered hornblende schist and biotite; rock fabric clearly visible; breaks and crushes to a fine, sandy loam; extremely hard when dry, firm to friable when moist; dark reddish-brown clay coatings on some joint faces in upper part; planes of cleavage are nearly vertical; many microsize interstitial pores; several feet to unweathered parent rock.

The A horizon is commonly brown to dark brown (10YR 5/3, 4/3; 7.5YR 5/4) but is grayish brown or dark grayish brown in places (10YR 5/2, 4/2). Moist colors range from dark brown to very dark grayish brown (7.5YR 3/2; 10YR 3/3, 3/2). Some small areas are reddish brown (5YR 4/3, 4/4) when dry and dark reddish brown (5YR 3/2, 3/3) when moist. The texture is commonly loam but in places is heavy sandy loam, heavy fine sandy loam, or light clay loam. The structure of the upper part of the A horizon is granular or fine subangular blocky and ranges in grade from moderate to strong. The lower part of the A horizon is massive or has structure that is similar to that of upper part but generally is weaker in grade. The A horizon is hard to slightly hard when dry, friable or very friable when moist and in some places slightly sticky when wet.

The B horizon ranges from reddish brown to dark reddish brown (2.5YR 3/4, 4/4; 5YR 4/3, 4/4, 5/4). Moist colors are dark

red to dark reddish brown (2.5YR 3 4, 3 6, 5YR 3 3, 3 4). The texture is mainly light clay but is heavy clay loam or sandy clay in places. The structure is commonly strong, coarse, angular blocky or subangular blocky. The consistence of the B horizon is hard to extremely hard when dry, firm to very firm when moist, and generally slightly sticky and plastic when wet. The sandy clay loam B3t horizon ranges from [illegible] brown to brown or grayish brown ([illegible] 4 2). The grayish color arises from [illegible] mineral fragments that are dominant in the sand fraction of the horizon.

The reaction of the profile is neutral throughout or [illegible] A horizon and neutral in the B horizon [illegible] the [illegible]. The solum ranges from about [illegible] inches in thickness to the underlying, well weathered parent rock. The parent rock is generally deeply weathered to a depth of many feet.

Trabuco loam, 45 to 70 percent slopes (ToF).—This very steep soil occupies hills and ridges in which there are well-defined drainageways. It has the profile described as typical for the series. The soil is widely distributed in the upper foothills from the vicinities of Humphreys Station and Tollhouse to those of White Deer Flat, Dunlap, and Squaw Valley.

The soil is somewhat excessively drained. The permeability of the subsoil is slow. Runoff is very rapid and the hazard of erosion is very high. The available water holding capacity is low to moderate, depending upon the depth of soil.

Included with this soil in mapping were similar soils that have a transitional horizon of clay loam between the loamy surface layer and the clayey subsoil.

Trabuco loam, 45 to 70 percent slopes, is used mainly for range. Some of the larger areas make up significant parts of some small watersheds. Those areas having a semidense cover of trees provide habitat for many kinds of wildlife. The grassy areas produce good to very good growth of forage. However, the very steep slopes reduce the grazing activity of livestock and many sites are undergrazed. Brushy areas provide some browse but not a great amount of forage. Changing the plant cover from brush to grass by controlled burning is not normally done, because the hazard of erosion and the difficulty and cost of controlling trees on very steep areas make it impractical. Although forage growth will increase by applying nitrogen fertilizers, the increase does not justify the expense and difficulty of application. Firebreaks cut through brushy areas can increase the utilization of browse, particularly by deer. Stock trails and planned location of salt licks can increase the utilization of forage by cattle. Capability unit VIIe–1 (18); range site 1; natural land type E9; Storie index rating 12.

Trabuco loam, 9 to 15 percent slopes (ToC).—This soil is in small areas in protected, shallow ravines in the middle and upper foothills. It has a profile that is similar to that of Trabuco loam, 45 to 70 percent slopes. The soil is well drained. Runoff is medium, and the hazard of erosion is slight to moderate. The cover is open and grassy, but there are some scattered oaks. There is little or no brush.

The soil is used for grazing and is well adapted to dry pasture. Nitrogen and phosphorus fertilizers improve growth and palatability of forage. For effective use as dry pasture, this soil should be fenced where it adjoins extensive areas of range. If local water is available, this soil is also adapted to pasture irrigated by sprinkler. Capability unit IIIe–8 (18); range site 1; natural land type E1; Storie index rating 51.

Trabuco loam, 15 to 30 percent slopes (ToD).—This soil has a profile that is similar to that of Trabuco loam, 45 to 70 percent slopes. It is on small hills or the side slopes of small valleys in the middle foothills. It is widely distributed in small areas from Black Mountain near Auberry to the vicinities of Squaw Valley and Dunlap. Runoff is medium to rapid, and the hazard of erosion is moderate to high. Some areas of the soil are brushy; others are open and grassy.

The soil is used mainly for range. Some open areas are adapted to use as dry pasture. The forage growth is good in the open areas. Converting brush to grass through controlled burning and seeding is practical. Forage plants respond well to fertilizing with nitrogen and phosphorus. Overgrazing should be avoided because of the susceptibility to erosion. Capability unit IVe–8 (18); range site 1; natural land type E1; Storie index rating 45.

Trabuco loam, 30 to 45 percent slopes (ToE).—This steep soil occupies hills and ridges in the middle and upper foothills. It has a profile that is similar to that of Trabuco loam, 45 to 70 percent slopes. In the middle foothills it is on north facing slopes. Most of the acreage of the soil has a semiopen cover of trees, mainly oaks. Some areas are brushy and less open. Occasional rock outcrops were included in mapping. Runoff is rapid, and the hazard of erosion is high.

Grazing is the principal use of this soil. Some of the larger areas comprise important segments of local watersheds. The forage growth can be improved by fertilizing with nitrogen and phosphorus. Overgrazing should be carefully avoided on this soil because of the high hazard of erosion. Stock trails or unpaved roads require runoff interception and side drainage. Unprotected trails or roads will wash out or gullies will form if there is no drainage interception. Capability unit VIe–8 (18); range site 1; natural land type E9; Storie index rating 24.

Trabuco very rocky loam, 30 to 45 percent slopes (TpE).—The profile of this soil is similar to that of Trabuco loam, 45 to 70 percent slopes, but there are many outcrops of parent rock. The outcrops occupy 2 to 25 percent of the surface of the areas mapped as this soil. The outcrops are light gray to dark gray in color, are subrounded to subangular in shape, and range from about 1 to 10 feet in diameter. Many outcrops are no higher than 2 to 3 feet, but some are as much as 10 feet high. This steep soil occupies protected steep canyon slopes in the lower foothills. It is on east-facing slopes in the San Joaquin River canyon, in the lower valley of Mill Creek, in Tretten Canyon, and on the Sand Creek drainage.

Included with this soil in mapping were small areas of similar soils that are hilly or moderately steep.

Trabuco very rocky loam, 30 to 45 percent slopes, is used principally for range. The rock outcrops offer refuge for small wildlife. The management of this soil is similar to that of Trabuco loam, 30 to 45 percent slopes. The outcrops tend to reduce the forage

yield, particularly where they occupy more than about 10 percent of the surface. Constructing roads or trails through areas of this soil is difficult because of the outcrops. Capability unit VIs-81 (18); range site 1; natural land type E12; Storie index rating 19.

Trabuco very rocky loam, 45 to 70 percent slopes (TpF).—This soil has a profile that is similar to that of Trabuco loam, 45 to 70 percent slopes. Outcrops occupy from 2 to 50 percent of areas mapped as this soil. They vary widely in size and shape, and they occur singly or in clusters. Some clusters, amounting to areas of rock several hundred feet across, were included in mapping the larger areas of the soil. Many large areas of this soil are on the upper parts of separate mountains or prominent ridges in the middle foothills. Many areas occupy northerly or easterly slopes. Most of this soil is south of the Kings River. North of the Kings River the soil is located on or near Black Mountain, south of Auberry.

The use and management of this soil are similar to those of Trabuco loam, 45 to 70 percent slopes. The outcrops provide refuge for many kinds of wildlife. There is a slight to severe reduction in forage production because of the outcrops. The trees in most areas spread a canopy over 40 to 80 percent of the surface, and this further reduces forage production. Some browse is available from the trees. The very steep slopes and the rockiness make it impractical to change the cover to grass through controlled burning. The larger areas of this soil comprise important parts of local watersheds. Capability unit VIIs-8 (18); range site 1; natural land type E12; Storie index rating 9.

Traver Series

The Traver series consists of well-drained soils that are typically saline-alkali affected under natural conditions. These soils are deep to moderately deep over compact silt. They formed in moderately coarse textured granitic alluvium under conditions in which a water table was close enough to the surface to permit seasonal capillary rise and evaporation of ground water. Over long periods of time, sodium salts were accumulated in the soil material.

The Traver soils occupy the lower, western parts of the young fans of the San Joaquin and Kings Rivers within the basin rim zone. The surface is nearly level to very gently undulating and has scattered low hummocks of wind-accumulated material and a few playas.

The soils are at elevations of 170 to 240 feet. The average annual precipitation is about 8 inches, and the average annual temperature is about 63° F. The growing season is 225 to 275 days. The natural vegetation consists of annual grasses and forbs and saline-alkali tolerant plants.

In a typical profile, the surface layer is mildly alkaline, light-gray sandy loam about 2 inches thick. The subsurface layer is strongly alkaline, white sandy loam 8 inches thick. The subsoil is very strongly alkaline, light brownish-gray light sandy clay loam about 13 inches thick. At a depth of 23 inches is a layer of very strongly alkaline, light yellowish-brown sandy loam, and at a depth of 53 inches or more is white silt that is stratified with medium textured and coarse textured material in the lower part.

Extensive pumping of the ground water for irrigation has lowered the water table so that these soils are now well drained, but they retain the excess salts and alkali that accumulated when the soils were not so well drained. About 61 percent of the acreage of Traver soils is underlain by an unrelated, compact silty substratum that restricts but does not seriously impede root and water penetration. Field crops do not appear to be adversely affected by the substratum, but reclaiming the soils from the excess salts and alkali is slowed by its presence. The soils, however, can be reclaimed for intensive farming.

If these soils are irrigated and reclaimed, they are used for many field crops. Irrigation water of good quality is available from local, moderately deep wells. The water table is at a depth of 30 to 50 feet.

Representative profile in a native pasture of alkali-tolerant plants and annual grasses and forbs, on the gently undulating lower part of the young fan of the San Joaquin River, at an elevation of 195 feet (about 5 miles W. of the town of Kerman; 1/16 mile N. of State Highway No. 180 and 70 feet W. of the E. line of sec. 6 in the SE1/4SE1/4 of sec. 6, T. 14 S., R. 17 E.):

A1—0 to 2 inches, light gray (10YR 7/2) sandy loam, grayish brown (2.5Y 5/2) when moist; massive, slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; abundant very fine roots; few fine to very fine tubular pores, many microsize interstitial pores, mildly alkaline (pH 7.4); very abrupt, wavy lower boundary.

A2—2 to 10 inches, white (10YR 8/2) sandy loam, grayish brown (2.5Y 5/2) when moist, nonsticky and nonplastic when wet; massive; hard when dry, very friable when moist; plentiful very fine roots that tend to concentrate along cracks; few coarse horizontal tubular pores, common fine and very fine random tubular pores, many microsize interstitial pores, slightly calcareous with disseminated lime; strongly alkaline (pH 8.6); abrupt, wavy lower boundary.

B2t—10 to 23 inches, light brownish-gray (2.5Y 6/2) light sandy clay loam, dark grayish brown (2.5Y 4/2) when moist; weak, very coarse, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; very few fine and very fine roots; many fine and very fine tubular pores; many thin clay films on ped faces and in pores that are yellowish brown (10YR 5/4) when dry and dark grayish brown (2.5Y 4/2) [illegible] lime, very strongly alkaline (pH 9.7); abrupt, irregular lower boundary.

C1—23 to 53 inches, light yellowish brown (2.5Y 6/4) sandy loam, light olive brown (2.5Y 5/4) when moist; massive; hard when dry, very friable when moist, nonsticky and nonplastic when wet; few fine and very fine tubular pores, many microsize interstitial pores [illegible] disseminated lime [illegible] (pH [illegible]); abrupt, irregular lower boundary.

IIC2—53 inches +, white (10YR 8/2) silt, grayish brown (2.5Y 5/2) when moist; massive; hard when dry, friable when moist, common fine and very fine random tubular pores; many, medium and fine, distinct mottles that are yellowish brown (10YR 5/6)

when dry and dark yellowish brown (10YR 4/4) when moist; slightly calcareous with disseminated lime, strongly alkaline (pH 8.8); stratified with medium and coarse textured material within a depth of a few feet.

The A1 horizon ranges from gray or light gray to very pale brown. The hue is 10YR or 2.5Y, the value is [illegible] and the chroma is 1 to 3. Moist colors range from dark grayish brown to brown. The moist hue is [illegible] dry hue, but the value is only 4 or 5 and the chroma is 2 or 3. The A2 horizon varies considerably in thickness within short distances; it ranges from a very pale coating on the top of the B2t horizon to a very pale [illegible] (10YR 8/3, 8/2) layer several inches in thickness. It is not distinguishable from the A1 when moist or after cultivation. The A horizon is commonly massive. Dry consistence is hard to slightly hard. Texture is sandy loam or fine sandy loam. Reaction ranges from mildly alkaline to strongly alkaline.

The B2t horizon ranges from light brownish gray to very pale brown. The hue is 10YR or 2.5Y, the value is 5 to [illegible] ranges from dark grayish brown to dark yellowish brown. [illegible] is heavy sandy loam, loam, or light sandy clay loam. The B2t horizon [illegible] subangular blocky structure. Consistence is generally hard or very hard when dry, friable when moist, and slightly sticky and slightly plastic or nonplastic when wet. The reaction is generally strongly or very strongly alkaline but is moderately alkaline in places.

The B2t and C horizons are typically saline-alkali affected. The A horizon varies considerably in this respect within short distances. Large areas have as little as 5 percent or as much as or more than 66 percent of the A horizon affected. The compact silty layers, or lenses, are within 5 feet of the surface in some places, but they occur at a depth greater than 5 feet in other places.

Traver sandy loam, moderately deep (0 to 2 percent slopes) (Ts).—This soil has a profile that is very similar to that described as typical for the series. It is distributed throughout the basin rim zone on the young fans of both rivers. Areas of the soil are variable in size and shape. Some are long and winding, and others have a broad, irregular form. The shape of all the areas suggests a meandering, or spreading, pattern of alluvial deposition from limited floods on very gently sloping plains. Some areas of the soil occupy low ridges formed by streams. This soil has compact silty layers at a depth ranging from 36 to 60 inches. In places there are small included areas in which the depth to the silty substratum is about 20 inches.

The subsoil and the horizons beneath it are normally saline-alkali affected. They are strongly to very strongly alkaline and at least slightly saline from an accumulation of salts. The surface layer is variable in this respect. In some places just the upper few inches of the surface layer is saline-alkali free, and in others the full thickness of the surface layer is unaffected. In many places, however, the surface layer is strongly affected throughout. Where the surface layer is saline-alkali throughout, plant growth is reduced or there is no vegetation. In areas devoid of vegetation, the soil material commonly is compact and appears sterile or is loose and puffy where nests of salt crystals have formed.

This soil is now well drained. Runoff is slow because of the gentle relief and moderate permeability. The permeability of the substratum is moderately slow, but there are occasional openings and cracks in the substratum. If the soil is reclaimed, the available water holding capacity is moderate to high, depending upon the thickness of the soil. If not reclaimed root exploration in the subsoil is limited by excess salts and alkali. There is a slight hazard of soil blowing.

Included with this soil is a small area of a similar soil that has been reclaimed and is no longer saline-alkali affected.

Unreclaimed areas of this soil are used for alkali pasture or are idle. Partly reclaimed areas are used for irrigated barley and permanent pasture. As reclamation proceeds, the soils are used for cotton, alfalfa, corn, grain sorghum, and sugar beets. Nitrogen fertilizers are required. For a discussion of reclamation procedures used in this area, see the section "Saline and Saline-Alkali Soils." The silty substratum slows the complete reclamation of this soil. When first reclaimed, the soil is free of pests and soilborne plant diseases. If contamination from infected soils is avoided, the need for sprays or fumigants will be minimal. Capability unit IIs-6 (17), range site not assigned; natural land type B2-2m, Storie index rating 34.

Traver sandy loam (0 to 2 percent slopes) (Tr).—The profile of this soil is similar to that of Traver sandy loam, moderately deep, but it lacks a compact, silty substratum within 6 feet of the surface. More of the surface layer of this soil is saline-alkali free than that of Traver sandy loam, moderately deep. The soil is widely distributed along the basin rim from Whites Bridge to Riverdale.

Included with this soil in mapping was a small area of similar soil that has been successfully reclaimed and is saline-alkali free to a depth of at least 5 feet.

The use and management of Traver sandy loam are similar to those of Traver sandy loam, moderately deep. Reclaiming this soil is somewhat easier because there is no compact substratum. Capability unit IIs-6 (17); range site not assigned; natural land type B1-2m, Storie index rating 36.

Traver fine sandy loam (0 to 2 percent slopes) (Tl).—This soil has a profile that is similar to that of Traver sandy loam, moderately deep, but has a fine sandy loam surface layer and lacks a compact silty substratum within 6 feet of the surface. It is mainly in the Whites Bridge-Tranquillity district or is near Riverdale. Isolated areas are also scattered near Burrel, Helm, and San Joaquin. If the soil is reclaimed, its available water holding capacity is high.

Included with this soil in mapping, near Whites Bridge and Tranquillity, was a small area of a similar soil that has a loam surface layer.

The use and management of Traver fine sandy loam are similar to those of Traver sandy loam. Because the available water holding capacity is somewhat higher, the spacing between irrigations can be increased slightly. Capability unit IIs-6 (17); range site not assigned; natural land type B1-2m, Storie index rating 38.

Traver fine sandy loam, moderately deep (0 to 2 percent slopes) (Tu).—At the time of mapping,

over half of the acreage of this soil was strongly saline-alkali affected throughout. Only a modest acreage had a surface layer that was saline-alkali free. It has a profile that is similar to that of Traver sandy loam, moderately deep. The soil is mainly on the basin rim between Burrel and Whites Bridge. A small area is located northwest of Laton. The available water holding capacity is moderate to high in reclaimed areas.

Included with this soil in mapping was a small area of a similar soil that has been completely reclaimed and is free of excess salts and alkali.

The use and management of Traver fine sandy loam, moderately deep, are similar to those of Traver sandy loam, moderately deep. Capability unit IIs-6 (17), range site not assigned; natural land type B2 2m; Storie index rating 36.

Tretten Series

The Tretten series consists of well-drained to somewhat excessively drained fine sandy loam soils that formed from the weathering of metamorphic basic igneous rocks. These soils are moderately deep to deep to weathered rock. They range from undulating to very steep and occupy ridges and hills. Slopes are 3 to 70 percent. In about three-quarters of the very steep areas, 10 to 50 percent of the surface is occupied by rock outcrops. The outcrops are angular and dark colored, but they are not prominent. They are variably distributed and in many places are hidden by brush.

The Tretten soils are mainly in the upper foothills south of the Kings River at elevations of 1,500 to 3,500 feet. Some areas of the soils are as low as 700 feet on certain northerly slopes or in protected areas in some small foothill valleys. According to elevation, the average annual precipitation ranges from 20 to 25 inches, the average annual temperature from 58° to 55° F., and the average frost-free season from about 150 to 200 days. The natural vegetation consists of trees, grasses, and shrubs. The trees are mainly blue oak and interior live oak; the grasses are mainly annuals, and they grow with associated forbs; and the shrubs are principally wedgeleaf ceanothus and mariposa manzanita. The canopy of woody vegetation ranges from open to dense.

In a typical profile, the surface layer is slightly acid, grayish-brown fine sandy loam about 13 inches thick. The subsoil is neutral, brown fine sandy loam. At a depth of about 36 inches is brown to light yellowish brown, weathered, fine-grained metamorphosed rock.

The soils are used for range, as watersheds, and as refuge areas for wildlife. Water is from a few springs and intermittent streams.

Representative profile in an area of range having a semiopen cover of blue oak, interior live oak, and wedgeleaf ceanothus, along with annual grasses and forbs, on a southwest-facing slope of 40 percent, at an elevation of about 1,600 feet (about 0.35 miles, airline, WSW. of Clingan's Junction along an abandoned section of State Highway No. 180 in the SW¼NW¼ of sec. 32, T. 13 S., R. 26 E.):

A11—0 to 4 inches, grayish-brown (2.5Y 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium to coarse, granular structure, slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; abundant fine roots, many fine tubular and interstitial pores; slightly acid (pH 6.5); abrupt, wavy lower boundary.

A12—4 to 7 inches, grayish-brown (2.5Y 5/2) fine sandy loam; very dark grayish brown (10YR 3/2) when moist, weak, medium, granular structure, slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; abundant fine roots, many fine tubular and interstitial pores, slightly acid (pH 6.4), abrupt, wavy lower boundary.

A3—7 to 13 inches, grayish-brown (2.5Y 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak medium subangular blocky structure, slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; roots and pores similar to those in A11 and A12 horizons, slightly more compact than those horizons; slightly acid (pH 6.5), clear, smooth lower boundary.

B21t—13 to 29 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) when moist; moderate, [illegible] subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and [illegible] plastic when wet; [illegible] roots; [illegible] thin clay films on ped faces, thin continuous clay films in pores; neutral (pH 6.6); gradual, smooth lower boundary.

B22t—29 to 36 inches, brown (10YR 5/3) heavy fine sandy loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; hard when dry, firm to friable when moist, slightly sticky and slightly plastic when wet; few fine roots; common fine tubular pores; common thin clay films on ped faces, continuous thin clay films in pores, slightly acid (pH 6.4); abrupt, wavy lower boundary.

C—36 inches +, brown to light yellowish-brown, weathered, fine-grained, metamorphosed basic igneous rock; rock fabric still visible; [illegible] clay coatings on fracture faces in upper part, some fine roots follow parting planes; many feet to unweathered rock.

Part of dried grasses and leaves from shrubs and hardwoods form a thin litter on the surface of the soil described in the foregoing profile.

The A horizon ranges from grayish brown to dark grayish brown (10YR 5/2, 4/2). Moist color is typically very dark brown to very dark grayish brown (10YR 2/2, 3/2). The structure is normally granular, but the horizon is massive [illegible]. The consistence is generally soft to slightly hard, but it may be hard where the soil has been trampled. When moist, the A horizon is friable to very friable. The texture is mainly fine sandy loam, but in places it is sandy loam or loam. The reaction of the A horizon is neutral to slightly acid. The thickness of the A horizon ranges from about 12 to 20 inches.

The B horizon is brown, dark brown, pale brown, or light yellowish brown, and in some places grayish brown (10YR 5/3, 4/3, 6/3, 6/4, 5/2). When moist, it is dark brown, dark yellowish brown, and in some places very dark grayish brown (10YR 4/3, 4/4, 3/2, 7.5YR 4/4). Texture ranges from fine sandy loam to loam. The B horizon is massive or has subangular blocky structure, and it has little more than common, thin clay films on the ped faces. The reaction is neutral to slightly acid. Consistence is slightly hard or hard when dry, friable to firm when moist, and generally slightly sticky and slightly plastic when wet.

The thickness of the solum ranges from about 24 to 40 inches. The parent rock is generally deeply weathered, in many places to a depth of 60 feet.

Tretten fine sandy loam, 30 to 45 percent slopes (TvE).—This steep soil occupies side slopes and hills near Tivy Mountain, Pine Flat Dam, and Dunlap. It has a profile that is similar to that described as typical for the series. It is somewhat excessively drained. Runoff is rapid. The hazard of erosion is high. The available water holding capacity ranges from very low to moderate, depending on the depth to weathered rock. The soil is moderately permeable.

This soil is used only for grazing. Forage production can be increased by fertilizing with nitrogen. Changing the cover from brush to grass is necessary in some areas to achieve full range use. Brushy areas provide some browse for livestock and also act as refuge sites for many small kinds of wildlife. Capability unit VIe-8 (18); range site 1; natural land type E9; Storie index rating 24.

Tretten fine sandy loam, 3 to 15 percent slopes (TvC).—This soil is undulating to rolling. It has a profile that is similar to that of Tretten fine sandy loam, 30 to 45 percent slopes. It lies in a small valley southwest of Dunlap and in a protected cove northwest of Squaw Valley. The soil is well drained. Runoff is slow to medium, and the erosion hazard is slight to moderate.

Included with this soil is a small area that has a loam surface layer.

This soil is tillable, and much of it is used for dry-farmed grain cut for hay. It is also well suited to use as dry pasture. If moisture is adequate, nitrogen fertilizers increase growth of forage. If water were locally available, this soil could be used for pasture irrigated by sprinklers. Capability unit IIIe-8 (18); range site 1; natural land type E1; Storie index rating 54.

Tretten fine sandy loam, 15 to 30 percent slopes (TvD).—This hilly soil is in the middle foothills. It has a profile that is similar to that of Tretten fine sandy loam, 30 to 45 percent slopes. In some areas, there are a few clusters of rock outcrops. The soil is well drained. Runoff is medium to rapid, and the erosion hazard is moderate to high.

Grazing is the principal use of this soil. Most areas are semiopen to open grassland and have only minor limitations because of brush encroachment. Forage growth is good, and fertilization with nitrogen is practical if there is adequate moisture. Capability unit IVe-8 (18); range site 1; natural land type E1; Storie index rating 45.

Tretten fine sandy loam, 45 to 70 percent slopes (TvF).—This very steep soil occupies parts of ridges and hills or mountains in the middle foothills. It has a profile that is similar to that of Tretten fine sandy loam, 30 to 45 percent slopes. Several areas of this soil are near Dunlap. Others lie in the vicinity of Tivy Mountain and Tretten Canyon. Runoff is very rapid and the erosion hazard is very high.

This soil is used mainly for range. The very steep slopes and semidense growth of shrubs and trees in places reduces the grazing intensity. It is not practical to fertilize the soil. Converting brushy areas to grass by controlled burning or spraying is not feasible. Development of stock trails and planned placement of salt blocks can improve the use of forage. The soil comprises a minor part of several small watersheds. Capability unit VIIe-1 (18); range site 1; natural land type E9; Storie index rating 11.

Tretten very rocky fine sandy loam, 45 to 70 percent slopes (TwF).—The profile of this soil is similar to that of Tretten fine sandy loam, 30 to 45 percent slopes, but outcrops occupy 2 to 50 percent of the surface. Most areas have more than 10 percent of their surface area occupied by rocks. The outcrops are dark colored and normally not very prominent. Much of the acreage of this soil is covered by a semidense to dense stand of trees and shrubs, and these hide the rocks. Most of this soil occurs in a few large areas on the canyon slopes of White Deer Creek and Mill Creek west and northwest of Dunlap. Runoff is very rapid and the erosion hazard is very high.

Because of the semidense to dense cover of shrubs and trees, this soil has only limited value for grazing. Open areas are not extensively grazed because of the very steep slopes. The rock outcrops and very steep slopes make converting brushy areas to grass by controlled burning impractical. Stock trails would increase the browse value for livestock and deer, and they would provide firebreaks and access for fire control. The soil is best used as a watershed for local drainage systems and as refuge areas for many forms of foothill wildlife. Capability unit VIIs-8 (18); range site 1; natural land type E12; Storie index rating 8.

Trimmer Series

The Trimmer series consists of moderately deep to deep, well-drained to somewhat excessively drained soils that have a sandy clay loam subsoil formed from the weathering of intrusive basic igneous rocks or metamorphic basic igneous rocks. The parent rocks include gabbro, diorite, metadiorite, and hornblende schist. The soils are undulating to very steep; they are in the uplands cut by many shallow ravines and some deep canyons. Slopes are 3 to 70 percent.

These soils are very extensive in the middle and upper foothills (fig. 6). They are at elevations of 1,000 to 3,500 feet. At the lower elevations they occupy relatively cool, protected areas, and at the higher elevations they are on warm, southerly slopes. According to elevation, the average annual precipitation ranges from 18 to 30 inches, the average annual temperature from 61° to 57° F., and the frost-free season from 175 to 200 days. The natural vegetation is trees, grass, and shrubs. The woody cover ranges from semiopen to dense. Common trees are blue oak, interior live oak, Digger pine, and California buckeye. Common shrubs are wedgeleaf ceanothus, birchleaf mountain-mahogany, poison-oak, mariposa manzanita, and fremontia. The grass cover consists of annual grasses, and these are mixed with forbs.

In a typical profile, the surface layer is slightly acid, grayish-brown loam about 14 inches thick. The subsoil is reddish-brown and yellowish-red sandy clay loam about 17 inches thick. It grades into deeply weathered parent rock at a depth of about 31 inches. The profile is slightly acid throughout.

Figure 6.—Typical landscape and vegetation of Trimmer soils.

The Trimmer soils are used principally for range but are also important as watersheds and wildlife habitat. Water for livestock is locally available in some springs, many intermittent streams, and from a few perennial streams. Many small earthen dams have been constructed to conserve runoff water [illegible] intermittent streams. Some of the ponds formed are used for recreation.

Representative profile in an area of range that has [illegible] facing slope of [illegible] percent [illegible] open stand of [illegible] oak and wedgeleaf ceanothus and a ground cover of [illegible] grasses and forbs at an elevation of 1,6[illegible] feet (about [illegible] miles [illegible] W-SW of Clingan's Junction, on the N side of Hughton Approach Road in the SW[illegible]NW[illegible] of sec. 32, T. [illegible]3 S., R. 26 E.):

A1—0 to [illegible] grayish brown ([illegible]) [illegible] brown [illegible] dark grayish brown [illegible] roots; few [illegible] tubular pores; slightly acid (pH 6.5); abrupt, wavy lower boundary.

A[illegible]—[illegible] brown [illegible] loam, brown [illegible] slightly hard when dry [illegible] slightly sticky and [illegible] when wet; [illegible] plentiful coarse roots; few [illegible] medium tubular pores; thin

continuous clay films lining tubular pores, slightly acid (pH 6.4), clear, smooth lower boundary

B21t—14 to 21 inches, reddish-brown (5YR 5/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist moderate, fine, angular blocky structure, very hard when dry, firm when moist, sticky and plastic when wet; plentiful coarse roots, few to common medium tubular pores; thin continuous clay films on ped faces and in pores; angular pebbles of parent rock are common slightly acid (pH 6.4); clear smooth lower boundary

B22. 21 to 31 inches, yellowish red (5YR 5/6) sandy clay loam, dark reddish brown [illegible] when moist; moderate, fine, angular blocky structure; very hard when dry firm when moist, slightly sticky and slightly plastic when wet; few fine roots; few to common [illegible] tubular pores; thin [illegible] on ped faces and [illegible] pebbles of parent rock are common slightly acid (pH [illegible]); clear wavy lower boundary

C 31 inches +, [illegible] original rock fabric [illegible] well fractured, parting planes are coated with dark reddish brown clay films in upper part, grades to unweathered rock with depth

Parts of dried grasses and the leaves of shrubs and oaks form a thin litter on the surface of the soil described in the foregoing profile.

The A horizon ranges from brown to grayish brown (10YR 5/3, 5/2) the darker [illegible] where the stand of trees is dense. When the horizon is moist, the color is typically very dark grayish brown (10YR 3/2). The A horizon generally has weak [illegible] granular structure, but in open grassy areas that have long been grazed, it is compact and massive. However, [illegible] of trees [illegible] the open, granular structure remains. The texture of the A horizon ranges from sandy loam to loam.

The B horizon is yellowish red, reddish brown, or yellowish brown (5YR 5/6, 5/4, 4/4, 10YR 5/6, 5/8) when dry and dark reddish brown to strong brown (5YR 3/3, 3/4; 7.5YR 5/6, 5/8) when moist. Texture is sandy clay loam to clay loam.

The reaction of the profile generally is slightly acid to neutral. In some places the B horizon is medium acid. The thickness of the [illegible] ranges [illegible]. The parent rock is weathered to a depth ranging from about 10 to 50 feet.

Trimmer loam, 30 to 45 percent slopes (TxE) This steep soil has the profile described as typical of the series. It occupies ridges and hills and is widely distributed in both large and small areas from the vicinity of Table Mountain, near Millerton Lake, southeastward to the neighborhood of Dunlap, south of the Kings River. The cover of trees is mainly semiopen, but it ranges to semidense in places.

The natural drainage is somewhat excessive. The permeability of the subsoil is moderately slow. Runoff is rapid, and the erosion hazard is high. The available water holding capacity is low to moderate. The deeply weathered parent rock provides considerable moisture storage below the normal zone of root growth. Some tree and shrub roots penetrate parts of it; they grow downward along weathered joints or cracks.

Included with this soil in mapping were minor areas of similar soils that have a surface layer of sandy loam or fine sandy loam.

Trimmer loam, 30 to 45 percent slopes, is used mainly for grazing. Forage growth can be increased and forage palatability can be improved through nitrogen and phosphorus fertilizers. Greenhouse studies during the course of this survey indicated that forage growth on this soil may also respond to applications of sulfur. Converting brushy areas to grass is feasible where areas of this soil are associated with larger areas of soils that are not so steep. To maintain the value of this soil for watersheds, overgrazing should be avoided. Capability unit VIe–8 (18); range site 1; natural land type E9; Storie index rating 24.

Trimmer loam, 3 to 15 percent slopes (TxC) —This soil is undulating to rolling and occurs in some of the foothill valleys. It has a profile that is similar to that of Trimmer loam, 30 to 45 percent slopes. It is distributed in many small areas in and near Burrough and Watts Valleys to Squaw Valley and the valleys of Mill Creek and Lefever Creek. The soil is well drained. Runoff is slow to medium, and the erosion hazard is slight to moderate.

Areas of this soil are used for range or for dry pasture and dryfarmed grain cut for hay. The soil is well suited to dry pasture. Response to fertilizer is similar to that of Trimmer loam, 30 to 45 percent slopes. Where the soil is used as dry pasture or for dryfarmed hay, fencing should be used to separate areas of this soil from those used for range. If water is available locally, sprinkler-irrigated pastures can be developed on areas of this soil to provide additional green feed for some livestock held on the range into the summer dry period. Capability unit IIIe–8 (18); range site 1; natural land type E1; Storie index rating 58.

Trimmer loam, 15 to 30 percent slopes (TxD) —This soil has a profile that is similar to that of Trimmer loam, 30 to 45 percent slopes. It is typically hilly or moderately steep and is widely distributed in the middle foothills. Some areas are located in the lower foothills on protected slopes. The soil is well drained. Runoff is medium, and the erosion hazard is moderate.

Included with this soil in mapping were some minor areas of similar soils that have a sandy loam or a fine sandy loam surface layer.

Trimmer loam, 15 to 30 percent slopes, provides excellent grazing. There is little loss of forage because of the brush. Most of the acreage supports an open to semiopen cover of blue oak. The cover of grass and forbs is nearly continuous. Management of this soil is similar to that of Trimmer loam, 30 to 45 percent slopes. Some areas of this soil are used for dry pasture where they adjoin similar soils that are more gently sloping. Capability unit IVe–8 (18); range site 1, natural land type E1; Storie index rating 49.

Trimmer loam, 45 to 70 percent slopes. (TxF) —This very steep soil occupies canyon slopes and ridges, chiefly in the middle and upper foothills. Some areas are in lower positions, on north-facing slopes of prominent ridges. Depth of soil ranges from about 2 to 3 feet to weathered rock. The soil is in large areas, mainly near Humphreys Station, Watts Valley, and Pine Flat Reservoir. Runoff is often rapid after the surface layer has become saturated. Natural drainage is somewhat excessive. Runoff is very rapid and the erosion hazard is very high.

The soil is used for range. Where grasses and forbs are able to grow, the forage production is good. How-

ever, much of the surface area is occupied by brush. The density of the woody vegetation ranges from semiopen to semidense. Where semiopen, the woody cover consists mainly of trees, and much more grass is available. The very steep slopes, however, tend to reduce the grazing activity of livestock so that the forage harvest is generally light and much residue is left. Applying fertilizer and converting from brush are generally not practical, because of the very steep slopes. Stock trails and planned distribution of salt licks can improve the distribution of grazing animals. Much of this soil comprises important segments of small watersheds. Capability unit VIIe-1 (18); range site 1; natural land type E9; Storie index rating 11.

Trimmer very rocky loam, 30 to 45 percent slopes (TyE).—The profile of this soil is similar to that of Trimmer loam, 30 to 45 percent slopes, but large, subangular, or subrounded outcrops of parent rock occupy from 2 to 25 percent of the surface. Parts of certain areas of this soil are stony as a result of the sporadic accumulation of colluvial material from higher lying, steeper soils. This soil is near Humphreys Station, on Hughes Mountain, and on the canyon slopes of Mill, White Deer, and Lefever Creeks. Natural drainage is somewhat excessive. Runoff is rapid and the erosion hazard is high.

Included with this soil in mapping were small areas of similar soils that are less steep. Also included were small areas of a similar soil that has a sandy loam surface layer.

Trimmer very rocky loam, 30 to 45 percent slopes, is used mainly for range. Brush does not seriously reduce the growth of forage. The woody cover is mainly semiopen and consists largely of oak trees. The management of the soil is similar to that of Trimmer loam, 30 to 45 percent slopes. The rock outcrops provide some refuge and nesting sites for small wildlife. Capability unit VIe-8 (18); range site 1; natural land type E12; Storie index rating 18.

Trimmer very rocky loam, 45 to 70 percent slopes (TyF).—The profile of this soil is similar to that of Trimmer loam, 30 to 45 percent slopes, but the soil is very steep and very rocky. Rocks occupy 2 to 50 percent of the surface, but in most places they occupy less than 25 percent. The more rocky areas have somewhat shallower soil and in places the slopes are less than 45 percent but greater than 30 percent. This very steep soil is on ridges and canyon slopes near Millerton Lake and Pine Flat Reservoir. It also occupies areas on the north or east slopes of Tivy Mountain, Dalton Mountain, and Jesse Morrow Mountain. The canyons and drainage slopes of Mill Creek, White Deer Creek, Russian Charley Creek, and Lefever Creek are also sites for areas of this soil.

The drainage is somewhat excessive in most places, but it varies because of the outcrops. Runoff is very rapid, and the erosion hazard is very high.

The soil is extensively used for range. It has importance in comprising significant parts of small watersheds and is part of a refuge area for wildlife of the foothills. If the rocks and brush do not interfere, the soil produces good yields of forage. The very steep slopes, however, discourage intensive grazing by livestock. Applying fertilizer is not practical, and changing areas of brush to grass is not generally feasible. Development of stock trails and planned location of salt blocks encourage more intensive use of the available forage. Stock trails also provide easier access for fire protection. Capability unit VIIe-8 (18); range site 1; natural land type E12; Storie index rating 8.

Trimmer-Tretten complex, 15 to 45 percent slopes (TzE).—This complex is on hills and steep ridges; most of the acreage has slopes of 30 to 45 percent. The complex consists of Trimmer and Tretten soils so intermingled that it is impractical to separate them at the scale used in mapping. Each of the two kinds of soil named makes up at least 20 percent of any given area.

The Tretten soil has a fine sandy loam surface layer. Its profile is similar to that described as typical for the Tretten series. The Trimmer soil has a loam surface layer and is similar to the soil described as typical for the Trimmer series. The complex is west of Clingan's Junction and near the confluence of White Deer and Mill Creeks. Near the creeks, there is a semidense cover of shrubs and trees and the surface is a series of low parallel ridges.

The soils of this complex are used for grazing. In White Deer Creek Canyon, they are also important as a natural area for wildlife of the foothills. Capability unit VIe-8 (18); range site 1; natural land type E9; Storie index rating 30.

Trimmer-Tretten complex, 45 to 70 percent slopes (TzF).—This complex consists of Trimmer loam and Tretten fine sandy loam so closely intermingled that it is not practical to separate them at the scale used in mapping. Each soil makes up at least 20 percent of any given area. The profile of each soil is similar to that described as typical of its respective series. The complex occupies parts of an intricate landscape made up of very steep ridges east of Squaw Valley and near the confluence of Mill and White Deer Creeks. The cover of woody vegetation ranges from open or semiopen to semidense. The dense areas are generally on north facing slopes of spur ridges.

The soils of this complex are used for range. They also are important as parts of watersheds. The management of this complex is similar to that for Trimmer loam, 45 to 70 percent slopes, and Tretten fine sandy loam, 45 to 70 percent slopes. Capability unit VIIe-1 (18); range site 1; natural land type E9; Storie index rating 11.

Tujunga Series

The Tujunga series consists of excessively drained loamy sand and sandy soils that formed in recent alluvium derived from granitic rocks. These soils occupy flood plains and fans of rivers and smaller streams. They are normally nearly level, but in places their surface is fluted by numerous parallel channels. The soils are gently to moderately sloping where they occupy former flood distributary channels. Slopes are 0 to 9 percent.

The soils are at elevations of 180 to 400 feet. The

average annual precipitation ranges from 8 to 12 inches and the average annual temperature is about 63° F. The average growing season ranges from 225 to 275 days. On the fans the natural vegetation consists of annual grasses and forbs in sparse stands. On the flood plains near streams, the soils support a dense riparian vegetation that includes willow, sycamore, vines, shrubs, and weeds.

In a typical profile, the surface layer is neutral, grayish-brown loamy sand about 4 inches thick. This layer overlies slightly acid, massive, brown loamy sand about 11 inches thick and brown light loamy sand 24 inches thick. At a depth of about 39 inches is light yellowish-brown sand that is slightly acid.

The Tujunga soils are used for many kinds of irrigated crops. These soils have very low available moisture holding capacity, and therefore they are not very well suited to farming. However, they generally occur as narrow areas that adjoin extensive areas of soils that are better suited to farming. Consequently, they are generally used with the better soils, planted to the same crops, and managed in accordance with the needs of the better soils. Generally, crops on the Tujunga soils lack adequate moisture, and growth is poor. Better growth is obtained where Tujunga soils can be managed independently. Irrigation water for these soils is obtained from irrigation district canals and from wells. The quality of the water is good to excellent. Domestic water is obtained from wells. The depth to ground water ranges from about 30 to 100 feet.

Representative profile in a nearly level, undisturbed site along a railroad right-of-way on the upper part of the young fan of Kings River, under a sparse cover of annual grasses and forbs, at an elevation of 350 feet (about 3 miles N. of the town of Parlier, 200 feet SE. of the junction of Newmark and Fantz Avenues in the NE¼SW¼SW¼ of sec. 1, T. 15 S., R. 23 E.):

A1—0 to 4 inches, grayish-brown (2.5Y 5/2) loamy sand, very dark grayish brown (10YR 3/2) when moist; very weak, medium and fine, crumb structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; plentiful microsize roots; many microsize interstitial pores; neutral (pH 7.0); abrupt, wavy lower boundary.

C1—4 to 15 inches, brown (10YR 5/3) loamy sand, dark brown (10YR 3/3) when moist; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; few very fine and microsize roots; many microsize interstitial pores and very few medium tubular pores; root bundles in the medium tubular pores; slightly acid (pH 6.5); gradual, smooth lower boundary.

C2—15 to 39 inches, brown (10YR 5/3) light loamy sand, brown (10YR 4/3) when moist; massive; slightly hard to loose when dry, very friable when moist, nonsticky and nonplastic when wet; very few fine and very fine roots; many microsize interstitial pores and very few very fine tubular pores; a few lenses of clean coarse sand; slightly acid (pH 6.5); gradual, wavy lower boundary.

C3—39 to 60 inches +, light yellowish-brown (10YR 6/4) sand that has thin lenses of coarse sand, brown (10YR 4/3) when moist, nonsticky and nonplastic when wet; single grain, loose when dry or moist; very few fine and very fine roots; many microsize interstitial pores; a few lenses of clean, coarse sand; slightly acid (pH 6.5).

The A1 horizon, or Ap horizon in cultivated areas, is grayish brown, brown, pale brown, light brownish gray, and very pale brown (10YR 5/2, 5/3, 6/3, 6/2, 7/3, and, in a few places, 2.5Y 5/2, 6/2). Moist colors are very dark grayish brown, dark grayish brown, grayish brown, and brown (10YR 3/2, 4/2, 4/3, 5/3). The A horizon is commonly massive, but in places it is single grain or has a very weak crumb structure. Consistence is slightly hard to loose when dry and very friable or loose when moist. The horizon is typically sand to loamy sand and contains varying amounts of cobblestones or pebbles. The reaction is neutral to slightly acid.

The C horizon is brown, pale brown, light brownish gray, or light yellowish brown (10YR 5/3, 6/3, 6/2, 6/4). The moist colors are brown, dark brown, yellowish brown, or dark yellowish brown (10YR 5/3, 4/3, 3/3, 5/4, 4/4). The horizon is generally massive but in places is single grain, particularly in the lower part. The consistence is slightly hard to loose when dry and very friable or loose when moist. The reaction is neutral to slightly acid.

Tujunga loamy sand, 0 to 3 percent slopes (TzbA).—This soil has the profile described as typical for the series. The soil is widely distributed on the young fans and flood plains of the San Joaquin and Kings Rivers and on the recent fans of some smaller streams. Areas of the soil are very irregular in shape but tend to take a winding, branching form that widens to as much as a quarter of a mile in places or narrows to about 20 feet in others. In places the soil is gently undulating, but most areas have been leveled for crops. The material below the surface layer is mainly loamy sand to a depth of 5 feet or more, but in many places it is stratified with sand, coarse sand, or loamy coarse sand. Few or no pebbles occur within the profile.

Runoff is very slow because the soil is rapidly permeable. The hazard of erosion is slight. The hazard is from wind rather than from water. The available water holding capacity is low.

Included with this soil in mapping were some small areas having a loamy coarse sand surface layer. Also included were areas of similar soils that overlie an unrelated substratum at a depth of less than 4 feet. The substratum consists either of light-gray, compact silty material or of brown, weakly cemented, slowly permeable sandy material.

Few areas of Tujunga loamy sand, 0 to 3 percent slopes, are idle. Nearly all of the acreage is used for irrigated crops, which include alfalfa, corn, cotton, grain sorghum, some irrigated pasture, peaches, plums, oranges, and raisin, table, and wine grapes. Peaches, plums, and oranges are grown only where the frost hazard is low.

The major concern in managing these crops is the maintenance of optimum moisture in the root zone. Because of the low available water holding capacity and rapid permeability of the soil, frequent irrigations are needed. The length of run of furrows or checks should be as short as possible. Sprinklers are suitable for irrigating pastures and tree crops. Fertilizing with nitrogen or phosphorus, or both, is necessary. Nematodes are particularly troublesome for peaches on this soil. Windbreaks are needed in places to protect seedlings on cleanly tilled fields. Maintaining the content of organic matter by returning shredded crop residues is beneficial. Capability unit IIIs-4 (17); range site

not assigned; natural land type A5; Storie index rating 76.

Tujunga sand, 0 to 3 percent slopes (TzaA).—Some areas of this soil adjoin the rivers and their distributaries. Others occupy the parts of former river distributary channels on the young fans or occur as small, irregular areas on recently deposited alluvial plains. This soil has a profile that is similar to that of Tujunga loamy sand, 0 to 3 percent slopes. The surface layer is very pale brown sand or coarse sand. The underlying material, to a depth of 5 feet or more, is similar in texture, or it consists of stratified sand and loamy sand. Uncultivated areas show only a very [illegible] tion of organic matter. The available water holding capacity is very low, and permeability is very rapid [illegible] soils that have a fine sand surface layer or that have a scattering of pebbles or cobblestones on the surface.

Much of the acreage of Tujunga sand, 0 to 3 percent slopes, is idle or is used for browse or for limited grazing. A few areas are used for irrigated pastures, and others are used to grow raisin or wine grapes. Some areas of the soil are used as sources of building sand or road materials. In various places along the edge of the Kings River, areas of the soil are used as small beaches. Capability unit IVs-4 (17); range site 11; natural land type A5; Storie index rating 54.

Tujunga loamy sand, 3 to 9 percent slopes (TzbB).—This soil has a profile that is similar to that of Tujunga loamy sand, 0 to 3 percent slopes. Areas of this soil are generally long, narrow, and winding. They occupy slightly incised channelways or gently to moderately sloping banks cut into the surface of the young fans of the rivers. A few areas are on small fans along the sides of the secondary river valleys. The areas of this soil are widely distributed in the secondary valley of the San Joaquin River from the vicinity of Friant to that of Pinedale; in the vicinities of Fowler, Selma, Sanger, Parlier, and Reedley in old distributary channels; and in similar positions near Calwa and Herndon. Runoff is slow, and the risk of water erosion is slight. Wind erosion is generally less of a hazard than water erosion.

Included with this soil in mapping was a small area of a similar soil that occupies a leveled alluvial bench along Wahtoke Creek near Navalencia. An unrelated, compact sandy substratum underlies this included soil at a depth of about 3 feet.

Much of the acreage of Tujunga loamy sand, 3 to 9 percent slopes, is used for vineyards. The management is similar to that for Tujunga loamy sand, 0 to 3 percent slopes. Irrigation is mainly in furrows on the contour. Some areas are idle or are used for limited grazing. Some of the depressions in the soil are used for trash dumps. Capability unit IIIs-4 (17); range site not assigned; natural land type A5; Storie index rating 68.

Tujunga loamy sand, gravelly substratum, 0 to 3 percent slopes (TzcA).—The profile of this soil is similar to that of Tujunga loamy sand, 0 to 3 percent slopes, but a thick bed of loose pebbles and cobblestones underlies the soil at a depth of 24 to 48 inches. Because of the gravel substratum, this soil has a very low available water holding capacity. There is also a slight restriction of internal drainage at the gravel substratum. The soil is in the secondary valley of the San Joaquin River near the mouth of Little Dry Creek and northwest of Pinedale. It is also on low alluvial [illegible] sand, gravelly substratum, 0 to 3 percent slopes, is used principally for gro[illegible] and wine grapes. Growth depends on adequate moisture to maintain the plants during the growing season. Frequent irrigations are required, but only enough water is needed to wet the soil to the depth of the underlying gravel. Excessive irrigation can build up [illegible]rated zone above the gravel that can be injurious to root growth. Some areas of this soil are idle; others have been mined for the gravel for use in construction. Capability unit IVs-4 (17); range site not assigned; natural land type A5; Storie index rating 62.

Tujunga cobbly loamy sand, 0 to 3 percent slopes (TzdA).—The profile of this soil is similar to that of Tujunga loamy sand, 0 to 3 percent slopes, but [illegible] cent of the volume of the soil to a depth of 5 feet or [illegible] aplite, and fine grained, acid igneous rocks. The cobblestones interfere with cultivation but do not prevent it. The available water holding capacity is very low.

This soil is mainly in the secondary valley of the Kings River east of Sanger and Centerville. Areas of the soil commonly have the shape of slightly meandering stringers; they spread in places to a somewhat palmate outline. On the flood plain the soils occur as low meandering ridges or elongated knobs slightly above the associated Grangeville soils. On the low alluvial bench from Oakhurst south to Wahtoke, the areas are in the same topographic position as the associated Hanford soils. A few areas of the soil are also near the mouth of Little Dry Creek in the secondary valley of the San Joaquin River.

Included with this soil in mapping were minor areas of similar soils that are gravelly rather than cobbly. The included soils are somewhat more easily tilled. They occur mainly with larger cobbly areas, but they also occur separately near Friant, Herndon, and Pine Flat Dam.

Tujunga cobbly loamy sand, 0 to 3 percent slopes, is used mainly for growing table and wine grapes. Some peaches and plums are also grown, but growth is only fair. The management is similar to that for Tujunga loamy sand, 0 to 3 percent slopes, but management must allow for the very low available water holding capacity of this soil. The wear and tear on tillage equipment is greater on this soil than on Tujunga loamy sand, 0 to 3 percent slopes. Small areas in the river bottom are used for limited grazing or for irrigated pasture, but the soil is not well suited to irrigated pasture. Capability unit IVs-4 (17); range site not assigned; natural land type A7; Storie index rating 38.

Tujunga soils, channeled, 0 to 9 percent slopes (TzeB).—The profile of the soils in this mapping unit is similar to that described as typical for the series, but the surface is uneven and channeled and the surface layer varies in texture. The channeled surface is the result of the seasonal flooding that took place before dams were used to control the rivers. The channels are not deep, and their narrow banks are mainly gently to moderately sloping, although in places they are steeper. Within short distances the surface layer varies from fine sand, sand, or coarse sand to loamy sand. Also, in some places it is sandy loam or fine sandy loam. Channel bottoms are either sandy or gravelly. Below the surface layer are randomly stratified sand, loamy sand, and gravel.

The vegetation is fairly dense and consists of willow, cottonwood, sycamore, and a few valley oaks as well as grasses, weeds, and variety of shrubs. The mapping unit mainly flanks the better drained areas of the Kings and San Joaquin Rivers or their distributaries in the broader areas of the secondary river valleys.

Much of the acreage of these soils is idle or provides browse for cattle that graze mainly on nearby irrigated pastures. Some areas have been cleared, leveled, and added to adjoining pastures. Many wild animals and birds find protection and habitat in the large areas of these soils. Some areas beside streams have been developed, publicly and privately, for low-cost recreation. Some cabin retreats are built in this riparian wilderness. In some areas sand and gravel are mined for construction material. Capability unit IVe-4 (17); range site 11; natural land type A5; Storie index rating 36.

Visalia Series

The Visalia series consists of deep, chiefly moderately well drained sandy loam and loam soils that formed in recently deposited granitic alluvium. The soils are nearly level to moderately sloping and their surface is smooth. They occupy slightly depressed areas on the floors of small valleys and coves or aggraded drainageways that have surfaces that are slightly below those of the surrounding areas. Slopes are 0 to 9 percent.

The soils are in numerous areas along the eastern edge of the San Joaquin Valley and in some small valleys in the foothills. They are at elevations of 300 to 600 feet in the San Joaquin Valley and up to about 2,000 feet in the foothill valleys. The average annual precipitation ranges from about 11 inches at the lower elevations to about 25 inches at the higher elevations. The average annual temperature ranges from about 62° F. in the valley to 59° F. in the foothills. The average growing season ranges from 175 to 275 days. The natural vegetation consists of a dense growth of annual grasses and forbs. There are a few blue oaks or valley oaks at the higher elevations.

In a typical profile, the surface layer is slightly acid, dark grayish-brown sandy loam about 10 inches thick. The surface layer overlies neutral, massive grayish-brown sandy loam. At a depth of about 48 inches is mildly alkaline, grayish-brown sandy loam that extends to a depth of 5 feet or more.

In the San Joaquin Valley, where irrigation water is available, these soils are suitable for vineyards, fruit trees, field crops, and irrigated pasture. In the foothill valleys, without irrigation water, the soils are well suited to dry pasture or dryfarmed hay crops. In the lower valley areas, irrigation water is available mainly from wells. Some areas are supplied by surface water from irrigation district canals. In the foothill valleys, water is from local intermittent streams, springs, and a few shallow wells in alluvial pockets. Some streams are dammed to conserve the water for use for livestock.

[illegible] level flood plain of Hills Valley Creek, at an elevation of 525 feet (about 5 miles N. of the town of Orange Cove; 1,500 feet E., 100 feet S. of the junction of North Avenue and Hills Valley Road in the NW¼SE¼ of sec. 24, T. 14 S., R. 24 E.):

A [illegible]

[illegible] when moist, nonsticky and [illegible]; few fine and medium roots, common medium tubular pores, many microsize interstitial pores; neutral (pH 6.9); clear, wavy lower boundary.

C—48 to 60 inches +, grayish-brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) when moist; massive; hard when dry, friable when moist, slightly sticky and nonplastic when wet; few medium and coarse roots, few medium tubular pores, many microsize interstitial pores; mildly alkaline [illegible]

The A horizon is commonly grayish brown or dark gray [illegible] The structure is weak granular, or in places the A horizon is massive. The consistence is generally slightly hard but is hard or soft in places. The reaction is neutral or slightly acid. The color of the AC horizon is similar to that of the A horizon but it is not gray. The hue is 10YR or 2.5Y. The AC horizon is massive. Its consistence and reaction are similar to those of the A horizon. Texture ranges from sandy loam to loam.

The C horizon is uniform in texture and massive in some places and is stratified in others. Where it is stratified, the sandier horizons are generally single grain. The color ranges from dark grayish brown to brown (10YR 4/2, 5/2, 4/3, 5/3). Moist colors range from very dark grayish brown to dark brown (10YR 3/2, 4/2, 3/3, 4/3). Texture ranges from sandy loam to loam. The reaction ranges from slightly acid to mildly alkaline.

Visalia sandy loam, 0 to 3 percent slopes (VaA).—This soil has the profile described as typical for the series. The soil is widely distributed in moderate and small areas in the Orange Cove and Citrus Cove districts. It is also near Friant, Clovis, and Academy as well as in many of the small foothill valleys from Auberry to Dunlap. The largest areas are near Clovis and Orange Cove.

The soil is generally moderately well drained. Runoff is slow to very slow because the soil is nearly level, lies in somewhat depressed positions, and has moderately rapid permeability. The hazard of erosion is none to slight. The available water holding capacity is high and slow seepage of moisture from surrounding higher soils keeps this soil moist and extends the natural season of plant growth. Saturation of the underlying material is not uncommon for short periods of time during the rainy season.

Included with this soil in mapping were minor areas of a similar soil that overlies thick, loose layers of gravel at a depth of about 24 to 48 inches. The available water holding capacity of the included soil is somewhat lower than that of this soil, and the gravel tends to impede internal drainage. Areas of the included soil are near Friant, Dunlap, and in Watts Valley. Small areas of Chualar, Chino, Hanford, Foster, and Hildreth soils, and a dark-colored soil similar to the Greenfield soils, were also included. There are also small inclusions of a similar soil that has a fine sandy loam or coarse sandy loam surface layer and other similar soils that are somewhat poorly drained or poorly drained. The various included soils make up 15 to 20 percent of many of the areas mapped as this Visalia soil.

In the foothill valleys, Visalia sandy loam, 0 to 3 percent slopes, is used mainly for grazing, dry pasture, and in some places, for dryfarmed grain or hay. Where irrigation water is available, there are small irrigated pastures. In the San Joaquin Valley, where irrigation water is normally available, the soil is used for alfalfa, irrigated pasture, cotton, vineyards for table, wine, or raisin grapes, and fruit trees such as olive, fig, peach, plum, and orange. The fruit trees are only in areas of low frost hazard. Fertilizing with nitrogen or nitrogen and phosphorus is required yearly. Sulfur is beneficial to alfalfa, and cotton requires addition of potassium. In places this soil remains excessively moist longer than adjoining, better drained soils. Tillage operations may therefore need to be delayed until the soil is drier so that the soil structure does not deteriorate and the permeability does not become lower. Capability unit I–1 (17, 18); range site not assigned; natural land type A1; Storie index rating 95.

Visalia sandy loam, 3 to 9 percent slopes (VaB).—This gently to moderately sloping soil is in numerous small valleys in the foothills. It developed on fans or small alluvial aprons derived locally from the surrounding residual granitic soils. It has a profile that is similar to the one described as typical for the series.

The general drainage is moderately good to good. The well-drained areas are on the steeper slopes. These areas are supplied with moisture from seepage from nearby upland soils. The moisture helps to maintain continued grass growth and, indirectly, the dark color of the surface layer. Runoff is slow to medium, and the hazard of erosion is slight.

Included with this soil are small areas of similar soils that have a fine sandy loam or a coarse sandy loam surface layer. Also included, in the upper foothill valleys, are similar soils that are medium acid and soils that have more clay in the subsoil. Other inclusions are stony, and still others are strongly sloping.

Visalia sandy loam, 3 to 9 percent slopes, is used mainly for grazing or for dry pasture. The forage growth is good and can be readily improved by fertilizing with nitrogen, phosphorus, and sulfur. Some areas are used for dryfarmed grain cut for hay. Small areas of irrigated pasture have been developed where small dams can provide sufficient water for irrigation. In the foothill communities, many home gardens are established on this soil. Capability unit IIe–1 (17, 18); range site not assigned; natural land type A1; Storie index rating 86.

Visalia sandy loam, clay loam substratum, 0 to 3 percent slopes (VdA).—The profile of this soil is similar to that of Visalia sandy loam, 0 to 3 percent slopes, but it overlies Ramona soils buried at a depth mainly of 3 to 4 feet but ranging from 2 to 5 feet. The buried Ramona soils appear to have been moderately to severely eroded before the deposition of the alluvium in which the Visalia soil developed. In most places the Visalia soil is underlain directly by layers of reddish-brown sandy clay loam or clay loam that are similar to the subsoil of Ramona soils. This Visalia soil is in two areas northwest of Clovis.

The clay loam substratum does not seriously restrict internal drainage, but perched zones of saturation can develop above it for short periods during the rainy season or from excess applications of irrigation water. The available water holding capacity is high.

Included with this soil in mapping was an area of a similar soil that has a gritty loam surface layer.

All of the acreage of Visalia sandy loam, clay loam substratum, 0 to 3 percent slopes, is irrigated and is used for alfalfa, cotton, irrigated pasture, figs, and peaches. The management is similar to that of Visalia sandy loam, 0 to 3 percent slopes. Excess applications of irrigation water should be avoided, particularly in areas used for peaches. Capability unit I–1 (17, 18); range site not assigned; natural land type A2; Storie index rating 81.

Visalia loam, 0 to 3 percent slopes (VeA).—The profile of this soil is similar to that of Visalia sandy loam, 0 to 3 percent slopes, but the underlying material is light loam or stratified sandy loam and loam. The soil is widely distributed in small areas in the foothills and in the eastern part of the San Joaquin Valley. Permeability is moderate. The available water holding capacity is high.

Included with this soil in mapping were very small areas of a similar soil that is somewhat steeper and has a clay loam surface layer.

Most of the acreage of Visalia loam, 0 to 3 percent slopes, is in foothill valleys where it is used for grazing and is well suited to dry pasture. Small areas of alfalfa and irrigated pasture are grown where irrigation water is available. In the San Joaquin Valley, small areas of this soil are associated with other soils used to grow wine grapes and irrigated pasture. Forage growth is improved by fertilizing with nitrogen, phos-

phorus, and sulfur. Capability unit I–1 (17, 18); range site not assigned; natural land type A1; Storie index rating 95.

Vista Series

The Vista series consists of well-drained to somewhat excessively drained, shallow to moderately deep soils of the uplands that formed in coarse-textured material weathered from granitic rock. The parent rock is mainly weathered quartz diorite that is low in content of dark minerals. The soils are undulating to very steep. Slopes are 3 to 70 percent. Some areas are studded with outcrops of parent rock.

These soils are located in the lower foothills at elevations mainly of 500 to 1,500 feet. Some areas on prominent, outlying hills or ridges are as high as 2,000 feet. According to elevation, the average annual rainfall ranges from 14 to 18 inches, the average annual temperature ranges 62° to 60° F., and the growing season from about 225 to 250 days. The natural vegetation consists of annual grasses and forbs at the lower elevations and annual grasses and forbs under open stands of blue oak with some scattered brush at the higher elevations.

In a typical profile, the surface layer is neutral to slightly acid, grayish-brown and pale-brown coarse sandy loam about 15 inches thick. The subsoil is massive, slightly acid, pale-brown coarse sandy loam that extends to a depth of about 30 inches. Weathered quartz diorite abruptly underlies the subsoil.

The Vista soils are used mainly as range for livestock. Some open areas having gentle slopes are used for dryfarmed grain or wild hay. Citrus plantings have been made in some areas that border the San Joaquin Valley. Vista soils also make up parts of watersheds, are used by wildlife of the foothills, and are used for recreation.

Water is limited in the areas of these soils. Some springs, specially designed shallow wells bored into the weathered rock, and intermittent streams provide water for livestock and domestic uses. Enough water for irrigation is generally not available locally. In years of normal or above normal rainfall, small dams on some intermittent streams store enough water for limited areas of pasture irrigated by sprinklers. The available water holding capacity ranges from low to very low.

Representative profile in range on a southwest slope, under a cover of annual grass and forbs and a few scattered blue oaks, at an elevation of 810 feet (about 10½ miles, airline, E. of the town of Friant on the E. side of Morgan Canyon Road, approximately 0.2 mile N. of its junction with Millerton Road, in the NW¼SW¼ of sec. 13, T. 11 S., R. 22 E.):

A11—0 to 2 inches, grayish-brown (10YR 5/2) coarse sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, very fine, granular structure, slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; plentiful fine and very fine roots; many very fine interstitial pores; neutral (pH 7.0); abrupt, wavy lower boundary.

A12—2 to 6 inches, pale-brown (10YR 6/3) coarse sandy loam, dark brown (10YR 4/3) when moist; massive; hard when dry, very friable when moist, nonsticky and nonplastic when wet; plentiful fine and very fine roots; many fine, and few medium tubular pores, many fine interstitial pores; slightly acid (pH 6.5); clear, wavy lower boundary.

A3—6 to 15 inches, similar to A12 horizon in color, texture, structure, and consistence, few fine and very fine roots; few fine and medium tubular pores; many very fine interstitial pores; slightly acid (pH 6.5); clear, wavy lower boundary.

B2—15 to 30 inches, pale-brown (10YR 6/3) coarse sandy loam, dark brown (10YR 4/3) when moist, massive; hard when dry, very friable when moist, slightly sticky and nonplastic when wet; some brown staining on sand grains, occasional bridging of clay films between grains, thin discontinuous pore coatings; very few fine and very fine roots; few fine and medium tubular pores; many very fine interstitial pores; slightly acid (pH 6.5); abrupt, wavy lower boundary.

C—30 inches +, weathered quartz diorite; original rock fabric clearly visible, thin discontinuous films or stains of brown (7.5YR 5/4) clay coatings on many pale-colored (10YR 6/2, 6/3) feldspar grains and some dark mineral grains, somewhat thicker clay films coat small parting planes in the weathered rock, grades irregularly with depth to less weathered rock without colloidal staining of mineral grains.

On the surface of the soil described in the foregoing profile, a thin litter is formed by parts of dried and partly decomposed grasses and forbs.

The A11 horizon ranges from ½ inch to 2½ inches in thickness. This horizon is missing if the soil has been excessively trampled by grazing animals or if it has been cultivated. The color of the A11 horizon is grayish brown (10YR 5/2) when dry and very dark brown to very dark grayish brown (10YR 2/2, 3/2) when moist. It has weak to moderate granular structure. The A horizon in cultivated or trampled areas is generally pale brown but ranges to light yellowish brown and in some places very pale brown (10YR 6/3, 6/4, 7/4). When moist, the A horizon is brown to dark brown (10YR 4/3, 4/4) and in places yellowish brown (10YR 5/4). The A horizon is usually massive but is weakly granular in places. Consistence is typically hard when dry and friable or very friable when moist. The reaction commonly is neutral to slightly acid but is medium acid in places. The total thickness of the A horizon ranges from about 6 to 18 inches. The boundary between the A and B horizons is clear or gradual.

The B2 horizon ranges from about 5 to 22 inches in thickness. The color ranges from pale brown to brown (10YR 6/3, 6/4, 5/3, 7.5YR 6/4, 5/4). When the horizon is moist, its color is dark brown or, in some places, yellowish brown (7.5YR 4/4, 10YR 4/3, 5/4). The horizon is generally massive, but in places it has weak subangular blocky structure with a few very thin clay films on some of the ped faces. The consistence is hard to very hard when dry, friable to very friable when moist, and in many places slightly sticky when wet. The reaction is typically neutral to slightly acid, but ranges to medium acid in some places. The parent rock beneath the solum is weathered to a depth ranging from 1 or 2 feet to as much as 20 feet.

Vista coarse sandy loam, 15 to 30 percent slopes (VfD).—This soil has the profile described as typical for the series. Areas of this soil range in size from about 20 acres to many hundreds of acres. They are widely distributed throughout the lower foothills. The surface consists of smooth rounded hills that are studded in places with light-colored rock outcrops. The cover of annual grasses and forbs is evenly distributed, and there are scattered blue oaks and some interior live oaks. The depth of soil to weathered parent rock

ranges from about 20 to 40 inches but most commonly is 24 to 36 inches.

The soil is well drained. Runoff is medium to rapid, and permeability is moderately rapid. The hazard of erosion is moderate to high. The available water holding capacity is low to very low.

Included with this soil in mapping were minor areas of a similar soil that is shallow. Also included were larger areas of a similar soil that has slightly more clay in the subsoil or a few thin lenses of yellowish clay just above the weathered parent rock. Along small drainageways, small areas of Hanford, Visalia, or Hildreth soils have also been included. Other included soils are those of the Fallbrook, Sesame, and Cometa series.

Vista coarse sandy loam, 15 to 30 percent slopes, [illegible] Because of the moderately steep slopes, cultivation is difficult in most places and no dryfarmed barley or grain cut for hay is grown. Where water has been made available through the construction of small dams on intermittently flowing streams, some pastures are irrigated from sprinklers. In years of normal or above normal rainfall, or under irrigation, forage responds well to fertilizers of nitrogen, phosphorus, and sulfur. The larger areas of this soil contribute a significant amount of runoff to local streams. Capability unit VIe-1 (17, 18); range site 6; natural land type E3; Storie index rating 34.

Vista coarse sandy loam, 3 to 9 percent slopes (VfB).—This soil is undulating to gently rolling. It has a profile that is similar to that of Vista coarse sandy loam, 15 to 30 percent slopes. The soil is well drained. Runoff is medium and the hazard of erosion is slight. There are some gullies and over-deepened natural drainageways in Squaw Valley, where areas of this soil have long been used for grain and hay crops.

Included with this soil along minor drainageways are small areas of [illegible] soils.

Range, [illegible] hay, and dryfarmed small grain are the common uses of Vista coarse sandy loam, 3 to 9 percent slopes. Small grains and annual grasses respond to applications of nitrogen and phosphorus, particularly during years of average or better than average rainfall. Legumes also respond to sulfur and add to the sources of nitrogen for the grasses. The greater available moisture holding capacity of this soil, compared to the shallow Vista soils, helps to produce more forage and gives a somewhat longer growing period of forage plants. Where irrigation water is available, this soil is suited to pasture irrigated by sprinklers or from contour ditches. Capability unit IIIe-8 (18); range site 6; natural land type E3; Storie index rating 41.

Vista coarse sandy loam, 9 to 15 percent slopes (VfC).—The surface of this soil is rolling. It has a profile that is similar to that of Vista coarse sandy loam, 15 to 30 percent slopes. Runoff is medium, and the hazard of erosion is moderate.

The use and management of this soil are similar to those for Vista coarse sandy loam, 3 to 9 percent slopes. Greater care, however, is needed to control [illegible] if the soil is used for dryfarming. Capability unit IVe-8 (18); range site 6; natural land type E[illegible]; Storie index rating 37.

Vista coarse sandy loam, 30 to 45 percent slopes (VfE).—This steep soil occupies ridges and hills. It has a profile that is similar to that of Vista coarse sandy loam, 15 to 30 percent slopes. Depth of soil ranges from 20 to 36 inches. This soil is in the lower foothills, mainly south of the Kings River in the general vicinity of Squaw Valley. It is somewhat excessively drained. Runoff is rapid, available moisture holding capacity is very low to low, and the hazard of erosion is high on unprotected slopes. The cover of woody vegetation is semiopen but generally somewhat more dense than that on Vista coarse sandy loam, 15 to 30 percent slopes.

This soil is used only for range, and it is well suited to that use. Applying fertilizer will increase [illegible] tion outweigh the benefits. Capability unit VIIe-1 (18); range site 6; natural land type E11; Storie index rating 18.

Vista coarse sandy loam, 45 to 70 percent slopes (VfF).—This very steep soil occupies ridges and hills; the slopes are mainly between 45 to 55 percent. There are a few rock outcrops, either singly or in clusters. It has a profile that is similar to that of Vista coarse sandy loam, 15 to 30 percent slopes. Depth of soil to weathered rock is about 24 inches. Most of this soil is south of Squaw Valley, but a few areas are in the vicinity of Humphreys Station and Hughes Creek, north of the Kings River. The general drainage is somewhat excessive. Runoff is very rapid, and the erosion hazard is very high. The available water holding capacity is very low.

The use and management of this soil are similar to those of Vista coarse sandy loam, 30 to 45 percent slopes. The very steep slopes reduce the intensity of use by grazing animals, particularly late in spring when the soil is drying out. Stock trails can be developed to gain better distribution of the livestock and [illegible] of the forage. Applying fertilizer is not practical. Capability unit VIIe-1 (18); range site 6; natural land type E11; Storie index rating 9.

Vista coarse sandy loam, shallow, 9 to 30 percent slopes (VgD).—The profile of this soil is similar to that of Vista coarse sandy loam, 15 to 30 percent slopes, but it is thinner. The depth to weathered rock is generally between 10 and 20 inches. Almost all the acreage lies north of the Kings River in the lower foothills. A few small areas are in the vicinity of Tivy Valley and the lower valley of Mill Creek.

The soil is somewhat excessively drained. Runoff is medium to rapid, and the hazard of erosion is high. The available moisture holding capacity is very low. The weathered parent rock has some porosity and is capable of storing some moisture. Root exploration of the weathered parent rock, however, is limited. Most roots tend to follow soil filled cracks in the weathered rock, and these are not abundant.

Northeast of Owens Mountain, along Little Dry

Creek, a minor area mapped as this soil includes many small areas of Friant soils having similar slopes.

Vista coarse sandy loam, shallow, 9 to 30 percent slopes, is used mainly for grazing. It is well suited to this use, but because of the shallowness of the soil, the response to fertilizer in areas of pasture and range is limited. In places the less steep slopes are dryfarmed to barley or grain cut for hay. The very low available moisture holding capacity makes dryfarming dependent upon the seasonal rainfall and its distribution. Some groves of citrus have been planted on this soil in places along the lower edge of the foothills where irrigation water is available. These areas are in a zone of relatively low frost hazard. The slopes, soil depth, and hazard of erosion are restrictions that limit use of this soil for irrigated crops, other than pasture irrigated by sprinklers. Capability unit VIe–41 (18); range site 7; natural land type E7; Storie index rating 24.

Vista coarse sandy loam, shallow, 3 to 9 percent slopes (VgB).—The profile of this soil is similar to that of Vista coarse sandy loam, 15 to 30 percent slopes, but it is thinner. Depth to weathered rock is generally between 10 and 20 inches. The soil is undulating to gently rolling, and it is well drained. Runoff is slow to medium, and the erosion hazard is moderate. The available water holding capacity is very low. Many areas adjoin nearly level or undulating soils of the San Joaquin Valley. The soil is mainly along the lower edge of the foothills north of the Kings River. A few small areas are in the Citrus Cove district.

Included with this soil are a few areas where there are a few clusters of rock outcrops. Also included are narrow areas of Hildreth soils along minor drainageways.

The use and management of Vista coarse sandy loam, shallow, 3 to 9 percent slopes, are similar to those of Vista coarse sandy loam, shallow, 9 to 30 percent slopes. The soil is better suited to specialized irrigated crops, such as citrus, where water is available for irrigation. Capability unit IVe–8 (18); range site 7; natural land type E7; Storie index rating 28.

Vista coarse sandy loam, shallow, 30 to 45 percent slopes (VgE).—The profile of this soil is similar to that of Vista coarse sandy loam, 15 to 30 percent slopes, but it is thinner. Depth to weathered rock generally is between 10 and 20 inches. This steep soil is on ridges and hills between Friant and Humphreys Station. Runoff is rapid, and the erosion hazard is high.

The soil is used for range. The soil and forage tend to dry out earlier in spring than deeper soils nearby, particularly during years when rain is lacking late in spring. Applying fertilizer is impractical because of the shallowness, very low available moisture holding capacity, and steepness of the soil. Capability unit VIIe–4 (18); range site 7; natural land type E16; Storie index rating 12.

Vista very rocky coarse sandy loam, 3 to 30 percent slopes (VkD).—This soil is widely distributed in the lower foothills. It has a profile that is similar to Vista coarse sandy loam, 15 to 30 percent slopes. Outcrops of parent rock occupy from 2 to 25 percent of the surface area. The outcrops are only slightly weathered. They are commonly rounded in shape and are 2 to 4 feet high, but in some places they are as much as 10 to 15 feet high. Their diameter ranges from about 1 to 50 feet. Most outcrops are darkened or have a blotchy appearance from lichen coatings. The soil material is not necessarily shallow adjacent to the outcrops.

Runoff is slow to rapid, but it varies somewhat because of the rock outcrops. The hazard of erosion is generally slight to high, but it also varies, depending upon local conditions of natural terracing or of sheet wash, which are controlled by the location, shape, and extent of the rock outcrops.

Pasture and range are the principal uses for this soil. The use of farm machinery is impractical because of the rockiness. Range fertilization is practical. The cover of woody plants normally growing on this soil is open to semiopen. In some areas the cover is semidense, mainly because of shrubs. The cover and rock outcrops provide good habitat for wildlife. There is some recreation furnished by the hunting of game birds. Capability unit VIs–1 (18); range site 6; natural land type E4; Storie index rating 27.

Vista very rocky coarse sandy loam, 30 to 45 percent slopes (VkE).—The profile of this soil is similar to that of Vista coarse sandy loam, 15 to 30 percent slopes, but rock outcrops occupy from 2 to 25 percent of the surface. The rock outcrops are only slightly weathered. Commonly they are rounded in shape, 2 to 4 feet high, and 1 foot to 50 feet in diameter. The soil is not necessarily shallow adjacent to the outcrops. This soil is somewhat excessively drained. Runoff is rapid, and the hazard of erosion is high. This steep soil is on ridges, hills, and canyon slopes from the vicinity of State Highway No. 168 southeastward through the lower foothills.

A small area of a similar, but extremely rocky, soil east of Academy was included in mapping.

This soil is similar in use and management to Vista very rocky coarse sandy loam, 3 to 30 percent slopes. The producation of forage is lower in areas that are most rocky. The steep slopes and the rockiness make fertilization impractical. Capability unit VIIs–3 (18); range site 6; natural land type E12; Storie index rating 14.

Vista very rocky coarse sandy loam, 45 to 70 percent slopes (VkF).—This very steep soil is on hills and ridges at the [illegible] of Squaw Valley. Rock outcrops make up from 2 to 50 percent of the surface. Many of the areas of this soil, however, have less than 25 percent of the surface covered by outcrops. Commonly the outcrops are only slightly weathered, rounded in shape, 2 to 4 feet high, and 1 to 50 feet in diameter. The profile of the soil is similar to that of Vista coarse sandy loam, 15 to [illegible] percent slopes. It is somewhat excessively drained. Runoff is very rapid, but it is locally influenced by the outcrops. The hazard of erosion is very high if the protective cover of grass is lost through fire or overgrazing.

This soil is used for range. Rocky areas provide

some refuge for wildlife. Production of forage is lower in the areas that have more outcrops. The very steep slopes reduce the intensity of use by grazing animals. Development of stock trails and planned placement of salt licks help to improve livestock distribution and encourage greater use of available forage. Fertilization is not practical. Capability unit VIIs 8 (18); range site 6, natural land type E12; Storie index rating 7.

Vista very rocky coarse sandy loam, shallow, 3 to 30 percent slopes (VlD).—The profile of this soil is similar to that of Vista coarse sandy loam, 15 to 30 percent slopes, but it is thinner and the soil is rocky. Depth to weathered rock generally is between 10 inches and 20 inches. Outcrops of parent rock of various sizes occupy from 2 to 25 percent of the surface. In most areas more than 10 percent of the surface is covered by rocks. The soil ranges from undulating to hilly. It is in the lower parts of the foothills from the vicinity of Millerton Lake southeastward to the vicinity of Round Mountain. Runoff is slow to rapid and the erosion hazard is moderate to high. The available water holding capacity is very low.

This soil is used only for grazing. It is not suited to dryfarmed grain or hay production, because of its very low available moisture holding capacity and surface rockiness. Dependable irrigation water is generally not available for developing irrigated pasture on the less steep slopes. Production of forage is lower on the more rocky areas. Response to fertilization is limited. Capability unit VIs 41 (18); range site 7, natural land type E8; Storie index rating 18.

Vista very rocky coarse sandy loam, shallow, 30 to 70 percent slopes (VlF).—This steep to very steep soil occupies rocky slopes on prominent ridges and hills. It has a profile that is similar to that of Vista coarse sandy loam, 15 to 30 percent slopes. Depth to weathered rock generally is between 10 and 20 inches. Rocks occupy from 2 to 50 percent of the surface. About one-third of the total acreage of this soil has rocks on more than 25 percent of the surface. Runoff is rapid to very rapid, and the hazard of erosion is high to very high in unprotected areas. The available water holding capacity is very low.

Grazing is the principal use of this soil. The rock outcrops provide some refuge for wildlife. The soil is droughty, particularly on southern exposures, and the forage production is affected by the percentage of surface area taken up by rocks. The steep slopes, shallow soil, and rockiness make fertilization impractical. These factors, particularly the steep slopes, reduce the intensity of grazing. Stock trails on slopes of more than 45 percent and a planned distribution of salt blocks encourage better use of the available forage. Capability unit VIIs-8 (18); range site 7; natural land type E16; Storie index rating 7.

Vista extremely rocky coarse sandy loam, 3 to 30 percent slopes (VmD).—The profile of this soil is similar to that of Vista coarse sandy loam, 15 to 30 percent slopes, but 25 to 50 percent of the surface is occupied by rock outcrops. Except for an area northeast of Round Mountain, the soil is located along parts of the moderately steep edge of the foothills south of the Kings River. Depth of soil to weathered parent rock is about 10 to 36 inches. On more than 50 percent of the acreage, the soil is less than 20 inches deep. Runoff is variable; it depends on the distribution and shape of the outcrops. The hazard of erosion is generally moderate to high; it also is variable and depends on natural terracing or on sheet wash, and this is controlled by the arrangement or extent of the outcrops.

This soil can be used for limited grazing and as refuge for wildlife. The outcrops reduce production of forage. Range fertilization is not practical. Capability unit VIIs 7 (17, 18); range site 10; natural land type E8; Storie index rating 11.

Vista-Fallbrook coarse sandy loams, 9 to 30 percent slopes (VnD).—This complex consists of Vista coarse sandy loam and Fallbrook coarse sandy loam soils that are so closely intermingled that it is not practical to separate them at the scale used in mapping. Each of the two kinds of soil makes up at least 20 percent of any given area, but the actual proportion is variable from place to place. The areas of this complex are east of the town of Friant.

The profile of the Vista soil is similar to that described as typical for the Vista series, but it is thinner. The depth to weathered parent rock is 10 to 20 inches. The profile of the Fallbrook soil is similar to that described as typical for the Fallbrook series but is slightly coarser textured, is thinner, and is free of rock outcrops. The depth to weathered parent rock ranges from 12 to 24 inches. The surface layer of the Fallbrook soils is commonly somewhat coarser textured in areas closely associated with Vista soils than in other areas.

The soils of this complex are well drained to somewhat excessively drained. Runoff is medium to rapid. The average available moisture holding capacity is very low. The hazard of erosion is moderate to high.

This complex is used for annual range and for dryfarmed grain. It is well suited to range. Forage response to fertilization is limited. Capability unit VIe 41 (18); range site 7; natural land type E7; Storie index rating 19.

Vista-Fallbrook very rocky coarse sandy loams, 3 to 30 percent slopes (VoD).—This complex consists of Vista and Fallbrook coarse sandy loams that are so intermingled that it is not practical to separate them at the scale used in mapping. The proportion of each soil is variable but each of the two kinds of soil makes up at least 20 percent of any given area. Rocks occupy from 2 to 25 percent of the surface. Depth of soil to weathered parent rock ranges from 20 to 40 inches but is commonly more than 24 inches. The profile of the Vista soil is similar to that described as typical for the series, but it is rocky. The profile of the Fallbrook soil is slightly coarser textured than the one described under the Fallbrook series. The areas of this complex are from the vicinity of Friant to Squaw Valley.

Runoff is slow to rapid, and the hazard of erosion is slight to high. The available moisture holding capacity is very low to low.

Included with this complex in mapping are small areas of two similar complexes. The soils of one included complex are shallow and rocky, and those of the other are moderately deep and nonrocky.

The soils of this complex are used for range and are well suited to this use. The rocks on the surface make tillage difficult or impractical. Range fertilization is a suitable practice. Capability unit VIs-1 (18); range site 6; natural land type E1; Storie index rating 30.

Vista-Fallbrook very rocky coarse sandy loams, 30 to 45 percent slopes (VoE).—This complex consists of Vista and Fallbrook very rocky coarse sandy loams on which rocks occupy from 2 to 25 percent of the surface. The proportion of each soil is variable but each of the two kinds of soil makes up at least 20 percent of any given area. Depth of the soil to weathered rock ranges from 20 to 40 inches but is commonly more than 24 inches. The complex is mainly in an area east of Academy, in the vicinity of Piedra, southwest of Bear Mountain, and on the north side of Squaw Valley.

The soils of this complex are somewhat excessively drained. Runoff is rapid, and the hazard of erosion is high.

Included with this complex are some minor areas of similar soils that are steeper or nonrocky. The steeper areas occupy parts of the watershed of Hughes and Fancher Creeks.

The soils in this complex are used for range, and they are well suited to this use. The steep slopes and rockiness make tillage impractical. Range fertilization is impractical because of the cost and difficulty of surface application. Capability unit VIIs-8 (18); range site 6; natural land type E12; Storie index rating 15.

Vista-Fallbrook extremely rocky coarse sandy loams, 30 to 70 percent slopes (VsF).—The proportion of each soil is variable but each of the two kinds of soil makes up at least 20 percent of any given area. Rocks occupy 25 to 50 percent of the surface of soils mapped in this complex. Depth to weathered rock is 20 to 40 inches. The complex is located entirely in the vicinity of Citrus Cove, north of Navelencia. Runoff is rapid, and the erosion hazard is high.

The soils of this complex are well suited to limited range or to use by wildlife. The intensity of grazing is reduced by the steep to very steep slopes, and the normal forage production is less than that for similar nonrocky soils. Fertilization is not practical. Capability unit VIIs-7 (17, 18); range site 10; natural land type E16; Storie index rating 5.

Waukena Series

The Waukena series consists of saline-alkali affected soils that formed in moderately coarse granitic alluvium under somewhat poorly drained to poorly drained conditions. A sandy clay loam subsoil underlies a fine sandy loam surface layer. The soils are nearly level, but under natural conditions they have a low hummocky microrelief. They formed along parts of the lower, western edges of the young fans of both the San Joaquin and King Rivers along the basin rim.

The soils are at elevations of 165 to 180 feet. The average annual precipitation is about 8 inches, the average annual temperature is about 63° F., and the average growing season ranges from about 225 to 275 days. The natural vegetation consists of salt and alkali-tolerant shrubs and plants and a poor growth of annual grasses. Much of the surface area is bare of vegetation.

In a typical profile, the surface layer is mildly alkaline to very strongly alkaline, gray to pale-olive fine sandy loam about 4 inches thick. The subsoil, in the upper part, is olive sandy clay loam that is strongly calcareous and very strongly alkaline. At a depth of about 15 inches is the lower part of the subsoil, a layer of pale-olive loam about 4 inches thick. This layer is strongly calcareous and very strongly alkaline. Underlying the subsoil are layers of pale-olive to light-gray loam, pale-olive sandy loam, and light-gray loamy fine sand.

The Waukena soils are not easily reclaimed, and only a small acreage is cultivated. Unreclaimed, natural areas are used for early spring grazing or alkali pasture and for recreational hunting. Reclaimed areas are used mainly for irrigated pasture. Water for irrigation and for livestock is obtained from wells at a depth of 40 to 80 feet. The quality of water is fair to good. Pumping for water has lowered the local water table to such an extent that these soils now are moderately well drained or well drained.

Representative profile in nearly level native pasture of short annual grasses and saline-alkali tolerant plants, on the lower margin of the large young fan of the Kings River, at an elevation of 178 feet (about 2½ miles E. of the town of San Joaquin, 100 feet S. and 150 feet W. of the junction of the extension of Parlier Avenue and the Main Line Canal Road, in the NW¼SE¼ of sec. 20, T. 15 S., R. 17 E.):

A1—0 to ¾ inch, grayish-brown (2.5Y 5/2) fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, platy structure; slightly hard when dry, friable when moist; nonsticky and nonplastic when wet; few fine and very fine roots, many microsize interstitial pores; mildly alkaline (pH 7.6); very abrupt, smooth lower boundary.

A21—¾ inch to 1¾ inches, gray to light-gray (5Y 6/1) fine sandy loam, gray (5Y 5/1) when moist; massive but some vertical cracks; hard when dry, friable when moist; nonsticky and nonplastic when wet; abundant fine roots matted along the vertical cracks; few very fine roots in soil mass; many microsize interstitial pores; slightly calcareous with disseminated carbonates; strongly alkaline (pH 8.9); abrupt, wavy lower boundary.

A22—1¾ to 4 inches, pale-olive (5Y 6/3) fine sandy loam, olive (5Y 5/3) when moist; massive but some vertical cracks; hard when dry, friable when moist, nonsticky and nonplastic when wet; abundant fine roots matted along vertical breaks, few very fine roots in soil mass; many microsize interstitial pores; slightly calcareous with disseminated carbonates; very strongly alkaline (pH 10.4); very abrupt, wavy lower boundary.

B21tca—4 to 15 inches, olive (5Y 5/4) sandy clay loam, olive (5Y 4/4) when moist; strong, coarse, columnar structure; very hard when dry, very firm when moist, slightly sticky and slightly plastic when wet; plentiful fine roots along structural faces, few fine roots penetrate structural units; very few

fine tubular pores; many thin clay films on structural faces darkened with organic stains, common, medium, distinct light-gray (5Y 7/2) mottles from segregated lime, strongly calcareous from the segregated lime, very strongly alkaline (pH 9.2), abrupt, wavy lower boundary

IIB22tca—15 to 19 inches, pale olive (5Y 6/4) loam, olive (5Y 5/4) when moist, moderate, medium and coarse, subangular blocky structure; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; no roots, many, medium, distinct, light-gray (5Y 7/2) mottles from segregated lime; strongly calcareous from disseminated carbonates and segregated lime; very strongly alkaline (pH 10.4), clear, wavy lower boundary.

II [illegible] 7/2) loam, pale olive to light olive gray (5Y 6/3 6/2) when moist, massive, slightly hard when dry friable when moist, very slightly sticky and nonplastic when wet; no roots; many microsize interstitial pores, few, fine, faint light-gray (5Y 7/2) mottles of segregated lime, strongly calcareous from both disseminated carbonates and segregated lime; very strongly alkaline (pH 10.3), abrupt wavy lower boundary

IIIC2—37 to 42 inches, pale olive (5Y 6/3) sandy loam, olive (5Y 4/3) when moist massive, slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; many microsize interstitial pores, few, fine, prominent mottles of yellowish [illegible] (10YR [illegible]) [illegible] seminated carbonates; very strongly alkaline (pH 9.8), abrupt, wavy lower boundary

IIIC3—42 to 61 inches, light gray (5Y 7/2) loamy fine sand, light olive gray (5Y 6/2) when moist, nonsticky and nonplastic when wet, many microsize interstitial pores, massive, soft when dry, very [illegible] when moist, few fine [illegible] yellowish brown (10YR [illegible]) [illegible] (pH 9.6)

The surface of the A11 horizon is covered with thin salt crust in places. The color of the A horizon ranges from grayish brown or gray to light brownish gray, light gray [illegible] the chroma is 0 or 2 or the hue is 5Y the value is 6 to 7 and the chroma is 1 to 3. Moist colors are dark gray, gray, dark grayish brown, grayish brown or olive. The moist hue and chroma remain the same, but the value is only 3 to 5. The A horizon is generally massive, but it is also weakly blocky or platy in places. It is commonly calcareous and ranges from mildly alkaline to very strongly alkaline in reaction. Texture is fine sandy loam or loam. The horizon ranges from about 2 to 6 inches in thickness.

The B2t horizon ranges from grayish brown or dark grayish brown to olive or olive brown. The hue is 2.5Y or 5Y, the value is 4 to 6, and the chroma is 2 to 4. Moist colors range from very dark grayish brown to olive or dark olive gray. The moist hue and chroma remain the same, but the value is only 3 or 4. Texture of the B21t horizon is clay loam, sandy clay loam, or silty clay loam. The structure is commonly strong, medium to coarse, columnar, but it is prismatic in places. Consistence ranges from hard to extremely hard when dry and firm to very firm when moist. Lime is variably segregated as nodules or soft masses, and the reaction of the horizon is moderately alkaline to very strongly alkaline. The thickness of the horizon ranges from about 8 to 20 inches.

The C horizons are generally massive and slightly hard to soft in consistence when dry. They are stratified and tend to be coarser textured with increasing depth. Lime accumulation in nodular and disseminated form tends to decrease with depth. Reaction ranges from moderately alkaline to very strongly alkaline.

The salt content varies considerably within short distances. The A and C horizons are free of soluble salts in some places but are as much as strongly affected in others; the B2t horizon ranges from slightly affected to strongly affected.

Waukena fine sandy loam (Wa).—This soil has the profile described as typical for the series. The soil formed in a fringe of alluvium from both the San Joaquin and Kings Rivers along the eastern edge of the basin flood plain. It is scattered in small areas from a point east of the town of San Joaquin to the vicinity of Whites Bridge.

The soil is normally saline-alkali affected. The thin surface layer is variably affected, but the dense subsoil is consistently affected. The layers are strongly alkaline to very strongly alkaline from adsorbed sodium and at least slightly saline from accumulated salts. For a discussion of saline-alkali soils and reclamation procedures, see the section "Saline and Saline-Alkali Soils."

The soil drainage has been improved. Runoff and permeability are very slow. The erosion hazard is none to slight. The available water holding capacity is low to very low because few or no roots are able to live in the saline-alkali affected subsoil. If the soil is reclaimed, this capacity is increased because roots are able to explore more of the subsoil and lower horizons.

Included with this soil in mapping were some areas that have a sandy loam surface layer.

Waukena fine sandy loam is used mainly for alkali pasture. A few small areas have been partly reclaimed for irrigated pasture. Some reclaimed or partly reclaimed areas have been included in rice fields or planted to cotton. Some areas of the soil near the Mendota Wildlife Management Area are diked and flooded to attract waterfowl for recreational hunting. The soil is more useful for recreational [illegible] farming. Capability unit IVs-6 (17); range site not assigned; natural land type B9-2a; Storie index rating 16.

Waukena loam (We).—This soil has a profile that [illegible] similar to that of Waukena fine sandy loam. It is [illegible]ly along the western edge of the basin rim between Tranquillity and Whites Bridge. Some areas have been randomly channeled by floodwater from the San Joaquin River. The individual areas are larger than those of Waukena fine sandy loam.

The saline-alkali conditions of Waukena loam are similar to those described for Waukena fine sandy loam, but more of the surface layer is affected. Consequently, more of the natural surface is bare of vegetation. East of Whites Bridge, a moderate area has little or no vegetation except for clumps of saltbrush and a few spears of annual grasses growing on low mounds. A salt crust, 1/4 to 1/2 inch thick, has formed on the surface of the bare soil between the mounds.

The reaction of the surface layer, including the salt crust, ranges from mildly alkaline to strongly alkaline. The subsoil has a weak columnar structure, and [illegible] organic matter [illegible] the structural faces. Texture of the subsoil is commonly clay loam. The reaction is moderately alkaline to strongly alkaline. The soil overlies permeable coarse sandy loam or loamy coarse sand layers at a depth of about 2 feet.

[illegible]

[illegible]

Wisheylu Series

The Wisheylu series consists of well-drained to somewhat excessively drained soils that have a loam and clay loam subsoil. These soils formed in upland areas from the weathering of basic igneous rocks, such as gabbros and diorites. The soils are smooth and range from undulating to very steep. Slopes are 3 to 70 percent slopes.

Wisheylu soils are on ridges and hills in the middle and upper foothills at elevations of 1,000 to 2,500 feet. At the lower elevations, the soils are in protected areas in canyons. According to elevation, the average annual precipitation ranges from 20 to 25 inches, the average annual temperature from 61° to 57° F., and the frost-free period from about 175 to 225 days. The vegetation consists of trees, grass, and shrubs. The dominant trees are blue oak, interior live oak, and Digger pine. The grasses are mainly annuals, but there are forbs and a few clumps of perennial grass. The main shrubs are wedgeleaf ceanothus, mariposa manzanita, and poison-oak.

In a typical profile, the surface layer is slightly acid, grayish-brown loam about 4 inches thick. The subsoil extends to a depth of about 40 inches. It is mainly dark-brown loam and clay loam, but it is grayish-brown sandy clay loam in the lowest 5 inches. This layer is slightly acid to neutral. It is underlain by light brownish-gray, strongly weathered parent rock.

The Wisheylu soils are used primarily for range. They also make up important parts of watersheds. Water for livestock is obtained from a few springs and from small intermittent streams that have been dammed in places to form ponds or lakes.

[illegible] facing slope of 48 percent, under annual grasses and forbs and a semiopen cover of blue oak and wedgeleaf ceanothus, at an elevation of 1,450 feet (approximately 2,800 feet S. of Cold Spring Rancheria along Vincent [illegible] NE [illegible] SW [illegible] R. 24 [illegible]

A1 [illegible]

B [illegible] 2) when moist, moderate [illegible] subangular blocky structure, hard when dry, friable when moist, slightly sticky and slightly plastic when wet, few medium and coarse roots, few to common medium tubular pores many thin clay films on ped faces and in [illegible]; slightly acid (pH 6.4), abrupt, wavy lower boundary.

B21t—24 to 35 inches, dark brown (7.5YR 4/2) clay loam, dark reddish brown (5YR 3/2) when moist, weak, medium, prismatic structure breaking to moderate, coarse, angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet, few coarse roots, few to common medium tubular [illegible] faces and in pores; some angular gravel of parent [illegible] slightly acid (pH 6.4), abrupt, [illegible]

B [illegible] pores; thin continuous clay films on pore faces; some angular gravel of parent rock, neutral (pH 6.7), abrupt, wavy boundary.

C [illegible] weathered parent rock, very dark grayish brown (2.5Y 3/2) when moist, original rock fabric indistinct; crushes to sandy clay loam texture; numerous fractures; thick clay films on the parting planes, grades to unweathered parent rock at depth of more than 10 feet.

[illegible]

The B2t horizon is distinguished by its dry colors that [illegible] brown to dark grayish brown (7.5YR 4/2) [illegible] In places the upper part of the B horizon is brown or yellowish brown (10YR 5/3, 5/4) and the lower part has a more yellowish hue (2.5Y). Moist colors generally range from very dark grayish brown to dark reddish brown (10YR 3/2, 3/3, 2.5Y 3/2, 5YR 3/2). Texture is commonly sandy clay loam, or clay loam. The structure ranges from moderate, coarse, angular blocky to weak prismatic. The lower part of the B horizon is massive. The reaction is slightly acid to neutral. The depth of soil to the weathered parent rock, or C horizon, ranges from about 30 to 60 inches.

Wisheylu loam, 45 to 70 percent slopes (WhF).—This soil has the profile described as typical for the series. The soil is in widely separated areas in the foothills on ridges in the vicinity of Cold Spring Rancheria, Table Mountain, Tivy Mountain, and Trollen Canyon. The soil is well drained to somewhat excessively drained. Runoff is rapid to very rapid, and the erosion hazard is high to very high. The available water holding capacity is moderate to high. Permeability is slow.

Included with this soil in mapping were some areas that have rock outcrops. Included near Table Mountain was a similar soil on the canyon slopes of the San Joaquin River. This included soil is mildly stony or gravelly and formed in mixed colluvium. The colluvium is derived from the basaltic capping of Table Mountain and the ancient streambed gravel underlying this capping.

Range is the principal use of this soil. The very steep slopes tend to reduce grazing intensity, particularly late in spring when the soil begins to dry out

and the footing becomes difficult for cattle. The soil is seldom more than lightly grazed. Areas of the soil are useful as small watersheds. Capability unit VIIe-1 (18); range site 1; natural land type E9; Storie index rating 15.

Wisheylu loam, 3 to 9 percent slopes (WhB) —This undulating to gently rolling soil has a profile that is similar to that of Wisheylu loam, 45 to 70 percent slopes. It is in areas of small to moderate size in Burrough and Watts Valleys and along the drainage valleys of Dry Creek, Zebe Creek, and Lefever Creek. Most of the areas have been cleared of woody vegetation.

The soil is well drained. Runoff is slow to medium, and the hazard of erosion is slight to moderate. A few gullies and overdeepened natural drainageways have formed in some cultivated areas.

Included with this soil in mapping were areas of similar soils that have a sandy loam or fine sandy loam surface layer.

A large acreage of this soil is used for dryfarmed grain cut for hay or for dry pasture. The rest is used for range in association with steeper soils. The soil is well suited to dryfarming because its available water holding capacity is moderate to high. Growth is improved by adding nitrogen fertilizers. Good sprinkler-irrigated pasture can be developed where enough irrigation water is available. Dryfarmed areas should be stubble mulched across the slope when they are fallow. Small check dams in gullies or overdeepened natural drains reduce erosion. Capability unit IIIe-8 (18); range site 1; natural land type E1; Storie index rating 60.

Wisheylu loam, 9 to 30 percent slopes (WhD) — This rolling to hilly soil is widely distributed in the foothills, and a large acreage is in and near Burrough Valley and Watts Valley. It has a profile that is similar to that of Wisheylu loam, 45 to 70 percent slopes. The soil has a variable cover of woody vegetation. Some areas have been cleared entirely or in part; others have a semiopen woody cover. The soil is well drained. Runoff is medium to rapid, and the erosion hazard is moderate to high.

Included with this soil in mapping were small areas of similar soils that have a sandy loam or fine sandy loam surface layer. Near Table Mountain, there are small inclusions of a similar soil that formed in mixed colluvium from the basalt capping of Table Mountain and underlying, ancient stream gravel. The included areas are in the San Joaquin River canyon and have a more dense woody cover than that of this mapping unit. One of the included areas has a stony surface. Also included in some areas near Humphreys Station are small areas of a similar soil that has a dense, gray clay subsoil.

Wisheylu loam, 9 to 30 percent slopes, is used mainly for grazing. Fertilizing with nitrogen is practical. Some of the more gently sloping areas have been cleared and are used for dryfarmed grain for hay or for dry pasture. Capability unit IVe-8 (18); range site 1; natural land type E1; Storie index rating 49.

Wisheylu loam, 30 to 45 percent slopes (WhE) — This steep soil occupies hills, ridges, or canyon slopes, mainly near Table Mountain and Humphreys Station. It has a profile that is similar to that of Wisheylu loam, 45 to 70 percent slopes. Some areas of the soil support a semidense cover of woody vegetation. The soil is somewhat excessively drained. Runoff is rapid and the erosion hazard is high.

Included with this soil in mapping were some areas having a fine sandy loam surface layer. Included in the San Joaquin River Canyon near Table Mountain were small areas of similar soils that formed from tuffaceous deposits, as well as basaltic and mixed gravel colluvium. Some areas of these included soils are subject to landslips.

Wisheylu loam, 30 to 45 percent slopes, is used only for grazing. Fertilization is practical where the woody cover is open or semiopen. Capability unit VIe-8 (18); range site 1; natural land type E9; Storie index rating 25.

Wisheylu very rocky loam, 3 to 30 percent slopes (WrD) — The profile of this soil is similar to that of Wisheylu loam, 45 to 70 percent slopes, but 2 to 25 percent of the surface is occupied by outcrops of parent rock. The outcrops are dark-colored, lichen-covered, subangular masses of gabbro-diorite that range from about 1 to 10 feet in diameter. Few are higher than about 5 feet. The surface is rolling to hilly. The soil is mainly on low rocky knolls in Burroughs and Watts Valleys, but some of the acreage is near Humphreys Station. The woody cover ranges from semiopen to semidense. The soil is well drained. Runoff is slow to rapid, and the erosion hazard is slight to high.

Included with this soil in mapping was a similar soil that has a sandy loam surface layer.

Wisheylu very rocky loam, 3 to 30 percent slopes, is used only for grazing. Fertilizing with nitrogen is practical in the more open areas. The outcrops and the woody vegetation provide refuge for small wildlife. Capability unit VIs-8 (18); range site 1; natural land type E4; Storie index rating 32.

Wunjey Series

The Wunjey series consists of silt loam soils, typically saline-alkali affected, that formed in recent, medium-textured, granitic alluvium. These soils formed under conditions in which the water table was within 6 feet of the surface. They are now well drained because the water table has been lowered through widespread pumping.

The Wunjey soils occupy alluvial benches along the San Joaquin River northwest of Kerman and aggraded flood distributary channels in parts of the basin rim lands west of Kerman. The soils are nearly level. In places the natural microrelief consists of slight channeling or a scattering of low hummocks.

The soils are at elevations of 175 to 200 feet. The average annual precipitation is about 8 inches, the average annual temperature is about 63° F., and the growing season ranges from 250 to 275 days. The natural vegetation consists of saltgrass, other plants tol-

erant of excess salts and alkali, such as common spikeweed, and some annual grasses and forbs.

In a typical profile, the surface layer is moderately calcareous, strongly alkaline, very pale brown and pale brown silt loam about 11 inches thick. Below 11 inches is moderately calcareous, moderately alkaline, pale-brown silt loam that extends to a depth of several feet.

Where the Wunjey soils are not irrigated, they are used for alkali pasture. Under irrigation, they are suited to field crops and permanent pasture after they have been reclaimed from the excess salts and alkali. Irrigation water is available mainly from moderately deep wells. The water is of fairly good quality. The water table is at a depth of 30 to 70 feet.

Representative profile in a nearly level fallow area formerly used for pasture, on a low, hummocky part of the young fan of the San Joaquin River under a sparse cover of volunteer pasture grasses, native annuals, and saline-alkali tolerant plants, at an elevation of 200 feet (about 7¼ miles, airline, NW. of the town of Kerman, 1,600 feet W. and 200 feet N. of the junction of Ashlan and Butte Avenues in the SE¼SW¼SE¼ of sec. 18, T. 13 S., R. 17 E.):

Ap—0 to 6 inches, very pale brown (10YR 7/3) silt loam, dark brown (10YR 4/3) when moist; cloddy, hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant very fine roots, few very fine vesicular pores, many very fine and microsize interstitial pores; moderately calcareous with disseminated carbonates, strongly alkaline (pH 8.8); abrupt, smooth lower boundary.

A1—6 to 11 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) when moist; massive; hard when dry, friable when moist, nonsticky and slightly plastic when wet; abundant very fine roots; many microsize and few fine tubular pores, moderately calcareous with disseminated carbonates; strongly alkaline (pH 8.7); clear, smooth lower boundary.

C1—11 to 25 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) when moist; massive, slightly hard when dry, friable when moist, nonsticky and slightly plastic when wet, plentiful fine roots, few coarse roots; many very fine tubular pores, common microsize tubular pores, few coarse vesicular pores, moderately calcareous with disseminated lime; moderately alkaline (pH 8.0); diffuse, smooth lower boundary.

C2—25 to 66 inches +, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) when moist; massive; slightly hard when dry, friable when moist, nonsticky and slightly plastic when wet, few medium roots, common microsize and very fine tubular pores, few coarse vesicular pores, moderately calcareous with disseminated lime; moderately alkaline (pH 8.0).

The A horizon ranges from light brownish gray to pale brown or very pale brown (10YR 6/2, 6/3, 7/3). When the horizon is moist, the color darkens to brown, dark brown, or dark yellowish brown (10YR 4/3, 4/4). If the A horizon is cultivated, it is weakly to moderately cloddy, but in undisturbed areas it is generally massive. Consistence ranges from soft to hard when dry. The hard consistence normally is caused by tillage or tramping compaction. The consistence is friable or very friable when moist and is generally slightly sticky or nonsticky and slightly plastic when wet. The texture ranges from fine sandy loam to silt loam.

The C horizon is similar in color to the A horizon both when dry and when moist. It is typically massive and ranges in consistence from soft to slightly hard when dry. The consistence is friable or very friable when the horizon is moist, and it is nonsticky and slightly or very slightly plastic when wet. The texture is similar to that of the A horizon but in places ranges to very fine sandy loam.

Although it is not indicated by color, the A horizon contains significantly more organic matter than the lower horizons. The profile is saline-alkali affected throughout, but the salt content and sodium saturation vary considerably from place to place. Reaction of both the A and C horizons is moderately alkaline to strongly alkaline. Both horizons are typically calcareous.

Wunjey silt loam (0 to 2 percent slopes) (Wu).—This nearly level soil has the profile described as typical for the series. The soil is located within the basin rim zone, principally on the outer parts of the young fan of the San Joaquin River east and northeast of Whites Bridge. In most of the acreage of this soil, less than one-third of the surface layer is saline-alkali affected. Included with this soil in mapping was a minor area of a similar soil that is not saline-alkali affected.

Wunjey silt loam is now well drained. Runoff is slow to very slow because the soil is nearly level and has moderately rapid permeability. The erosion hazard is none to slight. If the soil is reclaimed, the available water holding capacity is high.

Unreclaimed areas of this soil are grazed as alkali pasture. The permeability of this soil and a water table over 5 feet from the surface make the soil easy to reclaim. See the section "Saline and Saline-Alkali Soils" for a discussion of methods used. If the soil is irrigated and reclaimed, it is fairly well suited to vineyards. Cotton, alfalfa, and irrigated pasture are the principal crops grown on the soil. Capability unit IIs-6 (17); range site not assigned; natural land type B1-2s; Storie index rating 60.

Wunjey fine sandy loam (0 to 2 percent slopes) (Ws).—This soil is widely distributed along the basin rim between the San Joaquin River and the vicinity of the town of San Joaquin. It lies in many small areas, most of which occupy parts of narrow, aggraded streams channels. It has a profile that is similar to that of Wunjey silt loam. The material below the surface layer consists of stratified layers of fine sandy loam, very fine sandy loam, and silt loam. The available water holding capacity is high.

Included with this soil in mapping were small areas of similar soils that overlie layers of somewhat compact, white silty material at a depth of 24 to 42 inches. These included areas are northeast of Whites Bridge. The silty substratum does not seriously impede root or water penetration.

The use and management of Wunjey fine sandy loam would be similar to those of Wunjey silt loam, but because of the small size of the individual areas, this soil is generally used and managed in the same way as the adjoining larger areas of surrounding soils of the Traver, Pond, and Fresno series. Capability unit IIs-6 (17); range site not assigned; natural land type B1-2s; Storie index rating 60.

Yokohl Series

The Yokohl series consists of well drained soils on low terraces made up of old, mixed alluvium. The terraces were formed mainly by material transported from

upland areas of basic igneous rocks. A dominantly clay subsoil overlies a shallow to moderately deep, strongly cemented hardpan. These soils are nearly level to undulating; they have many low hummocks. Slopes are 0 to 9 percent.

The soils are in the eastern parts of the San Joaquin Valley near the foothills, at elevations of 400 to 600 feet. The average annual precipitation ranges from 12 to 15 inches, the average annual temperature is 62° F., and the average growing season ranges from about 250 to 275 days. The natural vegetation consists of annual grasses and forbs.

In a typical profile, the surface layer is slightly acid, reddish-brown loam about 7 inches thick. The upper part of the subsoil is slightly acid, reddish brown clay loam. In the lower part the subsoil is neutral, reddish-brown clay. At a depth of about 14 inches is a red and light-red, indurated, iron-silica cemented hardpan. Weakly to strongly cemented sandy material, several feet thick, underlies the hardpan.

Yokohl soils are used mainly for grazing or for dry-farmed barley. There is not generally enough water for irrigation in the areas near Round Mountain and Academy, where most of the soils are located. In and near Tivy Valley, northwest of Centerville, irrigation water is available, and some of the acreage is used to grow alfalfa, citrus, and some cotton.

Representative profile in a native pasture of annual grasses and forbs, on a remnant of an old, low stream terrace, at an elevation of 450 feet (about 4 miles, airline, SSW. of the community of Academy on the E. side of Academy Avenue, approximately 1,000 feet N. of its intersection with Bullard Avenue, SW¼ SW¼ of sec 2, T. 13 S., R. 22 E.)

A1—0 to 3 inches, reddish-brown (5YR 4/4) loam, dark reddish brown (5YR 3/4) when moist; massive; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant fine roots; many fine tubular pores; slightly acid (pH 6.5); abrupt, smooth lower boundary.

A3—3 to 7 inches, reddish-brown (5YR 4/4) heavy loam, dark reddish brown (5YR 3/4) when moist; weak, coarse, angular blocky structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant fine roots; many fine tubular pores; slightly acid (pH 6.5); abrupt, smooth lower boundary.

B1t—7 to 10 inches, reddish brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) when moist; strong, medium, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; plentiful fine roots; common fine tubular pores; many moderately thick clay films in pores, and few thin clay films on ped faces; slightly acid (pH 6.5); abrupt, smooth lower boundary.

B2t—10 to 14 inches, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) when moist; weak, medium, prismatic structure breaking to strong, medium and coarse, angular blocky structure; extremely hard when dry, firm when moist, sticky and plastic when wet; few fine roots; few fine tubular pores; continuous thick clay films on ped faces and in pores; neutral (pH 6.8); very abrupt, wavy lower boundary.

C1m—14 to 18 inches, red and light-red (2.5YR 4/6, 6/6) massive, indurated iron-silica hardpan formed by the cementation of mixed sandy materials, red and dark reddish brown (2.5YR 4/6, 3/4) when moist, some dark staining by manganese dioxide; few clay films on random fracture planes; gradual, irregular lower boundary.

C2m—18 to 60 inches +, similar in most respects to C1m horizon but less strongly cemented; consists of thin, indurated seams separated by several inches of weakly or strongly cemented sandy loam; clay films on fracture planes extend to depth of about 30 inches; neutral; several feet thick.

The A horizon ranges from brown to reddish brown (10YR 5/3; 7.5YR 5/2, 5/4; 5YR 4/4) but is commonly reddish brown. When the horizon is moist, the color ranges from dark brown to dark reddish brown (10YR 3/3; 7.5YR 4/2, 4/4; 5YR 3/3, 3/4). The A horizon is typically massive. Texture ranges from loam to clay loam. The consistence is hard or very hard when dry. The reaction is slightly acid to neutral.

The B horizon is typically reddish brown but is dark reddish brown or strong brown in places (2.5YR 4/4, 5YR 3/4, 4/4; 7.5YR 5/6). Moist colors are typically dark reddish brown (2.5YR 3/4, 5YR 3/3, 3/4) and in places yellowish red (5YR 4/6). The texture of the B2t horizon is typically clay, but this horizon contains gravel in some places close to the foothills. The structure is weak to moderate prismatic. Most prisms consist of a column of angular blocky peds. Dry consistence ranges from very hard to extremely hard. The reaction ranges from slightly acid to mildly alkaline, and the thickness ranges from about 3 to 20 inches.

The Cm horizons range in color from red to light red. The degree of cementation is somewhat variable in the upper part but decreases with depth. Lime is present in places as a cementing agent for the hardpan. The reaction of less strongly cemented parts of the hardpan layers ranges from neutral to moderately alkaline. The depth from the surface to the C1m horizon ranges mainly from about 12 to 40 inches.

Yokohl loam, 0 to 3 percent slopes (YhA).—This nearly level to gently undulating soil is in moderate-sized to small areas, mainly on remnants of an original terrace dissected by normal geologic erosion. It has a profile that is similar to that described as typical for the series. Some areas occupy small valleys along the edge of the foothills. The subsoil is not gravelly. Its thickness above the hardpan ranges from about 4 to 12 inches. The depth to hardpan ranges from about 12 to 20 inches, but some small areas of similar soils are included that are as deep as 24 inches to the hardpan.

Permeability is very slow. Runoff is slow; in places it is ponded in shallow swales between low hummocks. The hazard of erosion is none to slight. The available water holding capacity is low because of the shallowness of the soil.

Grazing is the principal use of this soil. The soil has a very low moisture reserve and tends to dry up quickly. Forage responds to nitrogen and phosphorus fertilizers if there is adequate moisture during the growing season. Where irrigation water is available, the soil is suited to irrigated pasture. Deep ripping of the hardpan is required in order to plant field crops. This may be practical in places where small areas of this soil exist in combination with larger areas of other deeper soils. Capability unit IIIs-8 (17); range site 8, natural land type C13; Storie index rating 24.

Yokohl loam, 3 to 9 percent slopes (YhB).—This gently to moderately sloping soil occupies terraces; it has low hummocky microrelief. It has a profile that is similar to that of Yokohl loam, 0 to 3 percent slopes. Areas of this soil are located near Owens Moun-

tain on the south side, west of Round Mountain, and in Wonder Valley, south of Pine Flat Dam. Runoff is slow to medium, and the erosion hazard is slight to moderate.

The soil is used for grazing. Its management is similar to that of Yokohl loam, 0 to 3 percent slopes. Overgrazing should be avoided. Water for irrigation is not readily available. Capability unit IIIe-8 (17); range site 8; natural land type C13; Storie index rating 21.

Yokohl loam, moderately deep, 0 to 3 percent slopes (YkA).—The profile of this soil is similar to that of Yokohl loam, 0 to 3 percent slopes, but the hardpan is at a greater depth. The depth to hardpan ranges from about 24 to 40 inches. The thickness of the clayey subsoil ranges from about 3 to 20 inches. In places the subsoil texture is no finer than heavy clay loam. The soil is in numerous small areas south of Owens Mountain, near Academy, in the vicinity of Round Mountain, along Holland Creek, and in Tivy Valley, Clarks Valley, and Citrus Cove. Because of the greater depth of soil over the hardpan, the available water holding capacity is higher than that of Yokohl loam, 0 to 3 percent slopes. However, it is still low.

Included with this soil in mapping was a small area of a similar soil that has a fine sandy loam surface layer. This inclusion is located near the flood control dam of Dry Creek, northeast of Clovis.

Most of the acreage of Yokohl loam, moderately deep, 0 to 3 percent slopes, is used for grazing and for dryfarmed barley. Forage growth is somewhat better on this soil than on Yokohl loam, 0 to 3 percent slopes. Therefore, there is somewhat less need for frequent rain during the growing season. Applying fertilizer to improve the growth of forage plants is practical. In the Tivy Valley, the soil is used for irrigated pasture, citrus, alfalfa, and cotton. Deep ripping of the hardpan is necessary in preparing the soil for irrigated crops. Continued care is needed, however, to avoid overirrigation and the saturation of the root zone. The massive, dense sandy material beneath the hardpan is not readily permeable and is not easily shattered by ripping tools. Capability unit IIIs-8 (17); range site 8; natural land type C13; Storie index rating 38.

Yokohl loam, moderately deep, 3 to 9 percent slopes (YkB).—The profile of this soil is similar to that of Yokohl loam, 0 to 3 percent slopes, but the hardpan is at a greater depth. Depth to the hardpan ranges from about 24 to 40 inches. The subsoil is 3 to 20 inches thick. Runoff is slow to medium, and the erosion hazard is slight to moderate.

Included with the soil in mapping were small areas of similar soils that have a sandy loam or a clay loam surface layer.

Yokohl loam, moderately deep, 3 to 9 percent slopes, is used mainly for grazing. Management is similar to that of Yokohl loam, moderately deep, 0 to 3 percent slopes. Overgrazing should be avoided. Capability unit IIIe-8 (17); range site 8; natural land type C13; Storie index rating 34.

Yokohl gravelly loam, 3 to 9 percent slopes (YlB).—The profile of this soil is similar to that of Yokohl loam, 0 to 3 percent slopes, but it is gravelly. The gravel consists of angular fragments of metamorphic volcanic rock, mainly hornblende schist, and aplitic or quartz vein rock. Gravel makes up 20 to 30 percent of the surface layers and even more than that percentage of the subsoil. In many places the hardpan consists of gravel imbedded in a strongly cemented sandy matrix. The soil is in small covelike valleys along the lower edge of the foothills near Owens Mountain, Academy, Round Mountain, Tivy Valley, and Clark Valley. Runoff is slow to medium, and the erosion hazard is slight to moderate. Available water holding capacity is very low.

Included with this soil in mapping were small areas of similar soils that are nearly level or have a gravelly clay loam or gravelly sandy loam surface layer.

Yokohl gravelly loam, 3 to 9 percent slopes, is used only for grazing. Applying fertilizer is not practical. Capability unit IIIe-8 (17); range site 8; natural land type C16; Storie index rating 15.

Yokohl clay loam, moderately deep, 0 to 3 percent slopes (YmA).—This soil occupies slightly depressed positions near Owens Mountain, near Round Mountain, and in Tivy Valley. The profile is similar to that of Yokohl loam, 0 to 3 percent slopes, but the surface layer is clay loam and the hardpan is deeper. The clayey subsoil ranges from about 10 to 20 inches in thickness. The hardpan is commonly at a depth between 30 and 40 inches, but in some areas it is at a depth of as much as 48 inches. Its degree of cementation is more variable than that described as typical, and in places there is no indurated upper part of the hardpan. In many places there is a greater amount of lime cementation in the lower part of the hardpan. The available water holding capacity is low to moderate.

Except in Tivy Valley, this soil is used for grazing and for dryfarmed barley. In Tivy Valley it is used for irrigated pasture, citrus, alfalfa, and cotton. Its general management is similar to that of Yokohl loam, moderately deep, 0 to 3 percent slopes. Capability unit IIIs-8 (17); range site 8; natural land type C13; Storie index rating 32.

Use, Management, and Productivity of the Soils

This section first defines the capability grouping of soils and gives suggestions for managing the soils in each capability unit. The soils are then rated in accordance with the Storie index and are grouped by natural land type. Then estimated yields for principal crops and optimum management practices are given. Following this is a discussion of saline and saline-alkali soils. Also discussed in this section is the suitability of the soils for range, for pasture, for engineering purposes, and for other nonfarm uses.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The

groups are made according to the limitations of the soils when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or engineering.

In the capability system, all kinds of soils are grouped at three levels, the capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, clayey, droughty, or stony; and *c*, used in some parts of the United States, but not in the Eastern Fresno Area, shows that the chief limitation is climate that is too cold or too dry for common crops in the Area.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils.

Capability units in California are given Arabic numbers that suggest the chief kind of limitation responsible for placement of the soil in the capability class and subclass. For this reason, some of the units within the subclasses are not numbered consecutively, and their symbols are a partial key to some of the soil features. The numeral used to designate units within the classes and subclasses are these:

0. A problem or limitation caused by sand or gravel in the substratum.
1. A problem or limitation caused by slope, or by actual or potential erosion hazard.
2. A problem or limitation of wetness caused by poor drainage or flooding.
3. A problem or limitation of slow or very slow permeability of the subsoil or substratum caused by dense clay layers or by a substratum that is semiconsolidated.
4. A problem or limitation caused by low available moisture capacity.
5. A problem or limitation caused by fine textured surface soil.
6. A problem or limitation caused by excessive salt or alkali.
7. A problem or limitation caused by rocks, stones, or cobblestones.
8. A problem or limitation caused by shallow depth of soil to hard bedrock or an indurated layer.
9. A problem or limitation caused by low fertility.

Some capability units end with a dual number, for example, 41. These units contain soils that have limitation or problems of a dual nature. The limitations in the example cited are caused by low available moisture capacity and by a high erosion hazard.

Land resource areas

In the Eastern Fresno Area, capability classification is further refined by designating the land resource area in which the soils in a unit occur. A land resource area is a broad geographic area that has a distinct combination of climate, topography, vegetation, water resources, land use, and general type of farming. Parts of three of these nationally designated areas are in the

Eastern Fresno Area. These areas and their numbers are Central Valley alluvial plains and terraces (17), lower and middle foothills of the Sierra Nevada (18); and forested mountainous uplands of the Sierra Nevada range (22). The number of the resource area is added, in parentheses, to the class, subclass, and unit designation for complete identification of the capability unit.

A soil in one resource area may have characteristics similar to those of a soil in another resource area and have the same capability unit symbol, but the climate, vegetation, crops that are suited, and the management practices needed may vary. For example, both capability unit VIs-1 (18) and VIs-1 (22) contain very rocky, deep, well-drained soils. The soils in capability unit VIs-1 (18) are in the middle or lower foothills and are not suited to coniferous trees, but those in capability unit VIs-1 (22) are in the mountainous uplands and are suited to forest vegetation.

Management by capability units[*]

In the following pages, the capability units of Eastern Fresno Area are described and management for the soils in these units is suggested. The mention of the soil series in these descriptions does not mean that all the soils in a series are in the capability unit. To determine the soils in each unit, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I-1 (17, 18)

Soils in this unit are very deep and are well drained or have altered drainage. They are level and nearly level and are in valleys on alluvial fans and plains. These soils are more than 60 inches deep. Soils of the Borden, Chino, Chualar, Foster, Grangeville, Greenfield, Hanford, Hesperia, Los Robles, Nord, Pachappa, Ramona, Temple, and Visalia series are in this unit. Texture of the soils ranges from sandy loam to clay loam.

Slopes range from 0 to 3 percent, and there is no erosion hazard. Soil reaction ranges from slightly acid to moderately alkaline. The available water holding capacity is 7.5 inches or more in a depth of 5 feet.

All climatically suited crops can be grown on these soils. Fertility is high, and response to management is good.

Land leveling can be done without exposing unfavorable soil material. Nearly all crops on these soils respond favorably if fertilizer that contains nitrogen and phosphorus is applied.

CAPABILITY UNIT IIe-1 (17, 18)

Soils in this unit are very deep to deep, well drained, and gently sloping to moderately sloping. They occur on fans in the valleys and on low benches. These soils are in the Atwater, Greenfield, Hanford, Honcut, Los Robles, and Visalia series. They are alluvial soils having no characteristics that appreciably impair root penetration or moisture storage. Surface textures range from sandy loam to loam.

Slopes are mainly 3 to 9 percent, and erosion hazard is moderate. Natural fertility is high. Permeability is moderately slow to moderately rapid. Available water holding capacity is 5.0 inches or more to a depth of 5 feet.

These soils are suited to alfalfa, cotton, deciduous fruits and nuts, grapes, irrigated pasture, and row crops.

Flood irrigation on the steeper slopes is a moderate management problem. Sprinkler irrigation is more suitable on the steeper slopes. Nearly all crops respond favorably to nitrogen and phosphorus fertilizers.

CAPABILITY UNIT IIe-1 (22)

Aiken loam, 3 to 9 percent slopes, is the only soil in this capability unit. It is a deep to very deep, well drained, upland soil. This soil is deeper than 48 inches and has moderate profile development. The subsoil ranges from clay loam to clay and is slowly permeable. This soil overlies basalt bedrock that generally is weathered or fractured. The soil above the bedrock is readily penetrated by roots and by moisture. Included with this soil in mapping are some rocky or stony areas of similar soils that are somewhat steeper, in part.

This soil is mostly in pasture. Where irrigation water is available, some areas have been cleared and are used for orchard, irrigated pasture, and hay. Timber and Christmas trees are also grown. Additional areas are suitable for clearing and cultivation.

Cultivated crops on this soil respond to nitrogen and phosphorus fertilizers, though readily soluble phosphates are not suitable. The remaining stands of open timber consist of ponderosa pine and incense-cedar. Growth of the trees can be improved by thinning, pruning, and protecting them from insects.

CAPABILITY UNIT IIw-2 (17)

Soils in this unit are very deep, permeable, somewhat poorly drained, and nearly level. They occur along stream bottoms or on flood plains. These soils are in the Grangeville series. The land type Sandy alluvial land is included in this unit. Surface textures range from sandy loams to loams, and are more than 5 feet deep. In some places stratification occurs below a depth of 2 feet. The water table fluctuates, but it normally is within 2 to 4 feet of the surface for much of the year. Some areas are affected by salts and alkali.

Slopes are less than 2 percent. Available water holding capacity ranges from 5.0 to 7.5 inches within a depth of 5 feet and is affected by the fluctuating water table. Reaction is neutral to moderately alkaline.

These soils are used for irrigated pasture or dryland pasture. Forage crops grow well.

Irrigation water should be applied carefully on these soils to keep the water table from rising. A drainage system is needed before deep-rooted crops can be grown. Effective deep reclamation of the saline-alkali areas is not feasible without drainage, but a balance can be maintained by growing shallow-rooted pasture grasses.

Nitrogen fertilizer benefits all crops except forage legumes. Response to phosphorus is favorable, and response to potassium is adequate.

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CAPABILITY UNIT IIs-0 (17)

Soils in this unit are nearly level and are as much as 48 inches deep over sand or gravel. These soils are in the Grangeville, Hanford, and Ramona series. They are on alluvial fans or flood plains, generally near stream channels. The surface layer ranges from sandy loam to loam.

Slopes are mainly less than 3 percent. Available water holding capacity ranges from 5.0 to 7.5 inches, and a small amount of moisture is available from the underlying gravel. Reaction is neutral to mildly alkaline.

These soils are suited to cereal grains, alfalfa, grapes, deciduous fruits and nuts, irrigated pasture, specialty truck crops, and cotton.

Leveling is commonly done prior to development of a surface irrigation system. Deep cuts may expose the sandy or gravelly substrata. Periods between irrigations generally are shorter than for similar deeper soils. Irrigation water should be carefully applied to avoid over irrigation. Nitrogen fertilizer benefits all crops under irrigation except legumes grown for forage. Legumes respond favorably to phosphorus fertilizer, but the response of other crops to phosphorus varies.

CAPABILITY UNIT IIs-3 (17)

Soils in this unit are nearly level and are in the Borden, Foster, Grangeville, Hanford, Hesperia, and Ramona series. Most of these soils are moderately deep to deep, are moderately well drained or well drained, and have a slowly permeable, partly consolidated substratum at a depth below 18 inches. The substratum is weakly cemented or compact, and is silty. The Foster and Grangeville soils, however, are somewhat poorly drained and are moderately deep to compact sediment. Depth to the substratum ranges from 18 to 48 inches.

Slopes are less than 3 percent. Available water holding capacity ranges from 5.0 to 7.5 inches. The substratum is slowly permeable.

These soils are suited to orchards, vineyards, alfalfa, and row crops. The Foster and Grangeville soils are less suited to orchards than the other soils in this unit.

Careful use of irrigation water is essential to prevent formation of an intermittent perched water table. Subsoiling or ripping are needed to effectively deepen the shallower soils before deep-rooted crops can be grown. Crops on these soils respond favorably to nitrogen and phosphorus fertilizers.

CAPABILITY UNIT IIs-4 (17)

Soils in this unit are nearly level and are in the Atwater, Foster, Grangeville, Greenfield, Hanford, Hesperia, and Honcut series. The land type Sandy alluvial land, leveled, is included with the soils in this unit. Most of the soils are well drained or have improved drainage, are nearly level, and are very deep. Surface textures range from sandy loam to fine sandy loam, and some soils are gravelly throughout their profiles.

Slopes are less than 3 percent. Available water-holding capacity is 5.0 inches or more for the 5-foot rooting depth. Permeability is mostly moderately rapid, but is moderately slow in some soils.

Except for root crops, such as sugar beets, all climatically suited crops can be grown on these soils. If irrigated, these soils are suitable to most field crops and row crops and to orchards and vineyards. Nonirrigated crops, such as cereal grains and hay, are not suited.

When leveling is done, fairly deep cuts can be made without much effect on the soil. Row crops, field crops, and some orchard crops respond favorably to nitrogen and phosphorus fertilizers.

CAPABILITY UNIT IIs-5 (17)

Soils in this unit are moderately deep to very deep, well drained to moderately well drained, and nearly level. They are on flood plains, colluvial fans, and terraces. These soils are in the Centerville, Merced, Porterville, and Temple series. The surface layer is clay or clay loam. Subsoil texture is mainly clay.

Slopes are mainly less than 3 percent. Available water holding capacity ranges from 6.0 to 15.0 inches. When dry, deep, wide cracks form in these soils (fig. 7). The soils absorb water very rapidly until the cracks close; then absorption is slow to very slow.

These soils are suited to field crops, forage crops, corn, cotton, and some other row crops. Orchard crops generally are not well suited, but citrus is suited in the thermal belts.

Preparing a seedbed is difficult because hard clods form unless the soils are worked at the right moisture content. Crops on these soils generally respond favorably to nitrogen fertilizer.

CAPABILITY UNIT IIs-6 (17)

This unit consists of very deep, saline soils and saline-alkali soils that are well drained or have altered drainage. These soils are in the Borden, Chino, Foster, Grangeville, Hesperia, Nord, Pachappa, Piper, Pond, Temple, Traver, and Wunjey series. Soil depth exceeds 5 feet in most soils. Surface texture ranges from coarse sandy loam to clay loam.

Slopes are less than 2 percent. Subsoil permeability is moderately rapid to moderately slow and does not greatly affect root penetration or the potential for reclamation. Available water holding capacity ranges from 6.0 to 9.0 inches, depending on soil depth. Reaction is neutral to strongly alkaline.

The salts and alkali in these soils limit use for crops, though the soils respond readily to reclamation. At present the water table is below the depth where it could obstruct reclamation or promote the return of salts and alkali to the soil. After reclamation, these soils are well suited to cotton, alfalfa, sorghum, and sugar beets.

Before reclamation, the content of salts and alkali in these soils ranges from moderate to high. Leveling, leaching, applying soil amendments, and establishing growing plants are ways of reducing the amount of salts and alkali. Slight amounts of salts or alkali are likely to remain, however, even after extensive recla-

Figure 7.—The deep, wide cracks shown in this Merced soil form when the soil dries.

mation. Continued careful management therefore is needed.

Most crops on these soils respond to nitrogen and phosphate fertilizers. In some areas, however, potassium fertilizer is needed.

CAPABILITY UNIT IIIs–5 (16)

Soils in this unit are well drained, very deep to moderately deep, and sloping to moderately steep. They occur on fans, terraces, and upland areas. These soils are in the Centerville, Cibo, Mt. Olive, and Porterville series. They consist of clay and are about 2 to 5 feet deep over very slowly permeable sediment or weathered rock. The soils crack when dry. Some areas are cobbly.

Slopes range from 3 to 30 percent. The erosion hazard is generally slight to moderate, though some areas are cut by shallow gullies. Reaction is slightly acid to moderately alkaline and most of the soils have a calcareous subsoil. Permeability is slow to very slow. Available water holding capacity ranges from about 6.0 to 15 inches.

These soils are suited to irrigated citrus, olives, cotton, tomatoes, and pasture. They also are used for dryland grain and pasture.

Most crops on these soils require nitrogen fertilizer for satisfactory growth, and some may need fertilizer that contains phosphorus and potassium. Preparing a seedbed in these soils is difficult.

CAPABILITY UNIT IIIs–8 (17)

Soils in this unit are well drained and smooth, gently sloping, or undulating. They occur on terraces. These soils are in the Academy, Pollasky, Rocklin and Yokohl series. Texture of the surface layer ranges from sandy loam to loam, and that of the subsoil from sandy loam to clay loam or clay. An indurated hardpan or consolidated sediment is at a depth of about 20 to 50 inches. Included in this unit are small areas of similar soils that have a hardpan at a depth ranging from about 12 to 20 inches.

Slopes range from 2 to 9 percent, and the erosion hazard is slight to moderate. Most of these soils have moderate to slow permeability above the hardpan; the hardpan is nearly impermeable. Available water holding capacity ranges from 3.75 to 7.5 inches. Fertility generally is low. Reaction is slightly acid to moderately alkaline.

These soils are better suited to irrigated pasture crops than to other crops. Olives, figs, grapes, and citrus can be grown, however, under good management. Some areas are used for dryland grain and pasture.

Crops on these soils generally respond favorably to nitrogen and phosphorus fertilizers.

CAPABILITY UNIT IIIe–4 (18)

Soils in this unit are gently sloping to rolling and moderately deep. They occur on uplands. These soils are in the Ahwahnee, Auberry, Blasingame, Coarsegold, Fallbrook, Keefers, Sesame, Tivy, Trabuco, Tretten, Trimmer, Vista, and Wisheylu series. The surface layer ranges from coarse sandy loam to clay loam. The soils are more than 20 inches deep over weathered acid igneous, basic igneous, and metasedimentary rocks.

Slopes range from 3 to 15 percent, and erosion hazard is slight to moderate. The soils on acid igneous material are more erodible than those on basic igneous material. The soils on steeper slopes have a higher erosion hazard than those on gentle slopes. Most soils on acid igneous rock that have slopes of 3 to 9 percent, and most soils on basic igneous rock that have slopes of 9 to 15 percent, have about the same erosion hazard. Permeability ranges from moderately rapid to slow. Available water holding capacity is 3.75 to 7.5 inches.

Range and dryland pasture are the principal uses of these soils. Dryfarmed grain-hay is grown on some of these soils. Citrus can be grown where the frost hazard is low and water is available for irrigation. Cover crops are needed in orchards.

Nearly all crops on these soils respond favorably to nitrogen and phosphorus fertilizers. Sulfur is needed to

stimulate growth of legumes on soils from acid igneous rock

CAPABILITY UNIT III—4 (17)

Soils in this unit are in the Dello series. They are somewhat poorly drained and poorly drained. They are nearly level and have water tables at depths of 3 feet or more. The water table has been lowered in some areas

Surface textures are sandy loam or loamy sand. Permeability is rapid to very rapid in the sandy substratum. Reaction is moderately alkaline throughout the profile. The available water-holding capacity is 3.75 to 5.0 inches.

When drained these soils are suited to most crops grown in the Area.

A drainage system is needed to maintain the water table below the root depth. Light frequent irrigations are required to maintain sufficient water in the root zone. Soil blowing may also be a hazard if the surface is left unprotected during periods of high winds.

CAPABILITY UNIT III—5 (17, 18)

Soils in this unit are somewhat poorly drained and slowly permeable. The water table is within 5 feet of the surface for significant periods. In areas that have sufficient rainfall in winter, the soils may be waterlogged or water may temporarily be ponded on the surface. These soils are in the Alamo and Hildreth series. They are nearly level and are in swales or depressions on old terraces. Texture of the surface layer and subsoil is mostly clay Little or no increase in clay content occurs in the subsoil

Erosion is not a hazard on these soils Available water holding capacity ranges from 5.0 inches in the Alamo soils to 15.0 inches in the Hildreth soils.

These soils are used for irrigated barley, cotton, sorghum, sugar beets, and pasture. Where irrigation water is not available, the soils are used for dryfarmed barley or for grazing. In years when rainfall is high, the barley is often drowned out by ponded water. Orchards are not well suited

Except for legumes grown for forage, crops on these soils respond favorably to nitrogen. Forage legumes and cereal grains respond favorably to phosphate. Leveling and drainage improvement are needed for maximum choice of crops.

CAPABILITY UNIT III—6 (17)

This unit consists of nearly level, well drained to moderately well drained soils. These soils have a slowly to very slowly permeable subsoil or substratum that severely restricts penetration of roots and water They are in the Atwater, Greenfield, Hanford, Hesperia, Honcut and Madera series. The surface layer ranges from loamy sand to clay loam. Depth to the clay layer, hardpan, or hard substratum ranges from 20 to more than 36 inches.

Slopes are mainly less than 2 percent, and erosion hazard is slight. Available water holding capacity ranges from 3.75 to 7.5 inches. Reaction is slightly acid to moderately alkaline.

These soils are well suited to shallow rooted field, row, truck, and forage crops. Practices are needed that maintain fertility and that make best use of the water supply

CAPABILITY UNIT III—7 (17)

This unit consists of nearly level to moderately sloping very deep to moderately deep, excessively drained soils that formed in recent alluvium. These soils are in the Atwater, Cajon, Calhi, Delhi, Grangeville, Hanford, Honcut, Los Robles, and Tujunga series. The surface layer ranges from loamy coarse sand to fine sandy loam Some of these soils are stratified, but in most of the soils, the subsurface layers consist of coarse-textured material. Some of the Cajon soils are slightly affected by salts and alkali. The Honcut soils have a gravelly substratum

Slopes range from 0 to 9 percent, and soil blowing is a hazard in areas that are clean cultivated. Available water holding capacity is about 3.7 to 6.0 inches in a depth of 5 feet. Permeability is generally rapid

Low water-holding capacity limits use of these soils, and most cropped areas are irrigated. Peaches, plums, cotton, alfalfa, grapes, melons, and sweetpotatoes are the irrigated crops grown Areas not irrigated are in native pasture.

Crops on these soils respond favorably to nitrogen, phosphorus, and potassium fertilizers. The saline-alkali affected soils can readily be reclaimed by leaching. In many areas nematodes are a problem in orchards where peaches and plums are grown.

CAPABILITY UNIT III—8 (17)

Soils in this unit are well drained to moderately well drained and are affected by salts and alkali They are 20 to more than 36 inches deep over compact silty sediment, semiconsolidated alluvium, or a hardpan. Some of the silty sediment is cemented with lime and silica. The alluvium generally is loam to sandy loam in texture. These soils are in the Borden, Chino, El Peco, Foster, Fresno, Grangeville, Hesperia, Madera, Pond, and Traver series The surface layer ranges from sandy loam to clay loam.

Slopes are mainly less than 2 percent. Except in areas being leveled for irrigation, the hazard of water erosion is slight. Permeability is moderately rapid to moderately slow above the substratum and very slow in the substratum. Available water holding capacity ranges from 3.75 to 6.0 inches

These soils generally require reclamation for good growth of crops, and most soils need ripping. Then such crops as cotton, sorghum, barley, irrigated pasture, corn, and sugar beets can be grown.

Before reclamation, the content of salts and alkali in most of these soils is moderate to high. Leveling, applying soil amendments, flooding and leaching, and providing drainage structures for removing excess water are ways of reducing the content of salts and alkali. Some salts and alkali are likely to remain, however, and continued careful management is needed. Most crops on these soils need nitrogen and phosphorus fertilizers.

CAPABILITY UNIT IIIs-8 (17)

This unit consists of nearly level, well drained soils that have a hardpan or a semiconsolidated substratum. Some of these soils are 24 to 36 inches deep. Others are shallower but can be deepened effectively by ripping. In places these soils are on distinct terraces, but other areas merge into areas of deep, recent alluvial soils. These soils are in the Academy, Exeter, San Joaquin, and Yokohl series. The surface layer ranges from sandy loam to clay loam.

Slopes range from 0 to 9 percent, and the hazard of erosion is slight to none. Permeability is moderate to slow in the subsoil and is very slow in the hardpan or semiconsolidated substratum. Available water holding capacity ranges from 3.75 to 5.0 inches. Reaction of the surface layer is neutral to slightly acid. Surface textures range from sandy loam to clay loam.

These soils are suited to irrigated pasture, cotton, grapes, deciduous fruits, alfalfa, and corn. They are not suited to walnuts. Some areas are suitable for citrus because of favorable air drainage.

Leveling and ripping are needed if these soils are used intensively. Leveling improves surface drainage of the soils that have mound-and-swale microrelief. The depth to which roots can penetrate is limited to the depth that ripping tools can shatter the underlying hardpan or substratum (fig. 8). Phosphorus and nitrogen fertilizers are needed for maximum growth.

CAPABILITY UNIT IVs-3 (17)

Soils in this unit are gently sloping to strongly sloping. They have a claypan, hardpan, or slowly permeable subsoil or substratum at a depth generally between 10 and 20 inches. As a result, penetration of roots and water is severely restricted. These soils are on dissected terraces. They are in the Alamo, Cometa, Keyes, Montpellier, Pollasky, Positas, Redding, Rocklin, and San Joaquin series. The surface layer ranges from coarse sandy loam to clay loam, and it is gravelly or cobbly in some areas.

Slopes generally range from 2 to 15 percent, but are as much as 30 percent in places. The erosion hazard is slight to moderate. Available water holding capacity is 2.0 to 4.0 inches. Fertility is moderately low to low.

These soils are better suited to such shallow-rooted crops as small grains, irrigated pasture, and dryland pasture than to other crops. Citrus is grown, however, on some of the soils that are in the thermal belt near the foothills and have been renovated by leveling and deep ripping.

Except on the gentle slopes, leveling is difficult to do without cutting into a restrictive layer. Sprinkling is the best method for applying irrigation water. Supplies of nitrogen and phosphorus are low in these soils, but the response of crops to these elements is not sufficient to justify the cost unless the soils are irrigated. Many legumes grown in the soils that formed on old granitic sediment respond to sulfur.

CAPABILITY UNIT IVs-4 (18)

Soils in this unit are shallow, are gently sloping to moderately steep and have low water holding capacity

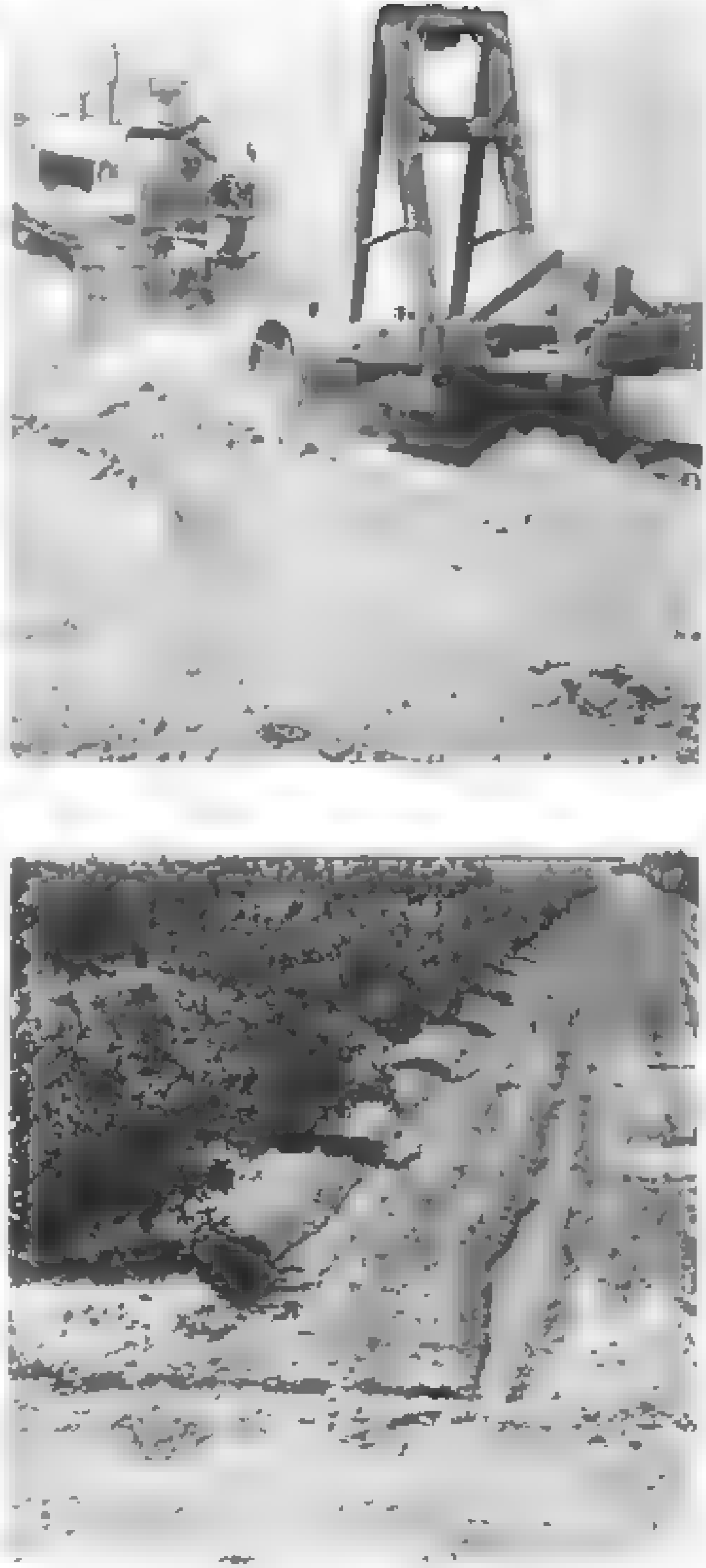

Figure 8.—Upper: Equipment capable of ripping a hardpan at a depth of 4 or 5 feet. Lower: A young orange grove on San Joaquin loam, 0 to 3 percent slopes, that has been ripped and leveled and has fragments of the hardpan on the surface.

These soils are in the Blasingame and Fallbrook series. The surface layer ranges from sandy loam to clay loam, and the subsoil is sandy clay loam or clay loam. Depth to bedrock ranges from 10 to 24 inches.

Slopes range from 2 to 30 percent, and erosion hazard is high. Available water holding capacity ranges from 2.0 to 3.5 inches.

Soils in this unit are used mostly for range, but hay or grain crops are grown in a few places on the gentler slopes. If water is available, irrigated pasture can be grown.

Irrigation by sprinkler is favored. If these soils are cropped, tillage should be across the slope. Most forage plants on these soils respond favorably to nitrogen and phosphorus fertilizers. Legumes on the Fallbrook soils respond favorably to sulfur.

CAPABILITY UNIT IVe-8 (18)

Soils in this unit are moderately deep and are rolling to hilly. They are in the uplands. Most of these soils are more than 20 inches deep over granitic and basic igneous rocks. They are in the Auberry, Blasingame, Cibo, Coarsegold, Fallbrook, Sesame, Sierra, Tivy, Trabuco, Tretten, Trimmer, Vista, and Wisheylu series. The surface layer ranges from coarse sandy loam to clay and the subsoil is similar in texture.

Slopes range from 9 to 30 percent, and erosion hazard is moderate to high. The soils on granitic material are more erodible than those on basic igneous material. Soils on granitic material that have slopes of 9 to 15 percent, and those on basic igneous material that have slopes of 15 to 30 percent, have about the same erosion hazard. Permeability below the surface layer ranges from moderate to slow. Available water holding capacity ranges from 4.0 to 6.0 inches.

Most of these soils are used for range, though some are used for grain-hay or wild hay. If water is available, irrigated pasture or such irrigated crops as apples can be grown.

Cover crops are needed in orchards. The soils in this unit respond favorably to nitrogen and phosphorus. Leguminous forage plants on the granitic soils respond to sulfur.

CAPABILITY UNIT IVs-4 (17)

This unit consists of nearly level to moderately rolling, very deep, excessively drained soils formed in recent alluvium or wind deposited materials. The soils in this unit are in the Delhi and Tujunga series. Surface textures range from sand to loamy sand, and the soils may be gravelly or cobbly throughout the profile. Some of the soils are stratified but most are sandy or cobbly throughout.

Slopes range from 0 to 9 percent and soil blowing can be a hazard when the surface is not protected by vegetative or other cover. Available water holding capacity is about 2.0 to 4.0 inches for the 5-foot rooting zone. Permeability is rapid to very rapid.

These soils are not suited to most irrigated crops grown in the Area. Water-holding capacities are too low for dryland crops. Grapes, melons, and sweetpotatoes are among the irrigated crops suited to these soils. Nonirrigated areas are used for limited dryland pasture.

These soils require frequent light irrigations and fertilizer applications to avoid leaching the limited nutrients from the profile, and to avoid applying excess water. Crops respond favorably to nitrogen and phosphorus fertilizers.

CAPABILITY UNIT IVw-6 (17)

Soils in this unit are nearly level, moderately well drained, and strongly saline to saline-alkali. They occur on the basin flood plain and on the basin rim. Soils of the Piper, Merced, Rossi, and Waukena series are in this unit, and the Playas land type. The surface layer of these soils ranges from fine sandy loam to clay and contains moderate to large amounts of salts, alkali, or both. The subsoil is sandy clay loam to clay loam, is slowly to very slowly permeable, and contains more salt and alkali than the surface layer. The water table has been lowered considerably in the areas where soils of this capability unit occur.

These soils are used for alkali pasture and occasionally for such alkali tolerant crops as cotton, sugar beets, and barley.

Reclaiming the surface layer is feasible, but reclaiming the subsoil is slow and has met with little success. Reclamation requires the use of large amounts of gypsum and water. Gypsum is generally used at the rate of 5 tons of 90 percent gypsum per acre. These soils are difficult to irrigate. Frequent irrigation is needed to keep the shallow surface rooting zone wet, and to provide moisture for the crops. Open or closed drains have been used to improve the natural drainage, and to take care of excess water during irrigation.

CAPABILITY UNIT Vw-1 (17)

The land type Swamp makes up this unit. This land type consists of medium textured to moderately coarse textured, poorly drained, very deep, stratified materials derived from granitic alluvium. The water table is at or above the surface because of seepage from the Kings River and from nearby irrigated areas at higher elevations.

This land type is used for native pasture and browse. If drainage facilities, including interceptive drains and sump pumps are installed, most common crops suited to the Area can be grown.

CAPABILITY UNIT VIe-1 (17, 18)

Soils in this unit are hilly, well drained, and moderately deep to deep. The available water holding capacity is 4.0 to 7.0 inches. They are more than 24 inches deep to weathered bedrock. These soils are in the Ahwahnee, Auberry, Fallbrook, Pollasky, Sesame, Sierra, and Vista series. The surface layer is coarse sandy loam or sandy loam, and the subsurface layer is coarse sandy loam to clay loam.

Slopes range mainly from 15 to 30 percent but some slopes range to 45 percent. Erosion hazard is moderate to high. Permeability is moderately rapid to moderately slow.

These soils are better suited to grazing than to other

uses. They are poorly suited to crops. Steep slopes and susceptibility to erosion make the soils poorly suited to crops that require frequent tillage

CAPABILITY UNIT VIe-1 (22)

Soils in this unit are hilly to steep, are well drained, and are more than 48 inches deep These soils are in the uplands. They are in the Holland and Shaver series. Their surface layer is coarse sandy loam, and their subsoil is coarse sandy loam to clay loam

Slopes range from 15 to 45 percent. The erosion hazard is moderate to high, but past erosion is slight. Available water holding capacity ranges from 6.0 to 10 inches

On these soils the native vegetation is partly open coniferous forest of ponderosa pine, incense-cedar, black oak, and canyon live oak. The understory is bearclover, mariposa manzanita, and wedgeleaf ceanothus. Annual grasses and forbs grow in the open areas. The soils in this unit are used mainly for grazing and as homesites, residences, or recreation. Little of the conifer timber cover is harvested

CAPABILITY UNIT VIe-3 (17)

Soils in this unit are mostly moderately steep and are on old terraces. They have a claypan or a slowly permeable subsoil at a depth between 6 and 20 inches. These soils are in the Cometa, Montpellier, Pollasky, Positas, and Redding series. The surface layer ranges from coarse sandy loam to gravelly loam.

Slopes range from 0 to 45 percent, and the erosion hazard is moderate to high. Available water holding capacity is 3.0 to 4.0 inches. The claypan severely restricts penetration of plant roots and water. Reaction ranges from slightly acid to strongly acid.

Soils in this unit are suited to grazing, but they are not suited to cultivated crops.

The content of nitrogen and phosphorus is low in these soils In years when rainfall is average or above, forage plants respond well if fertilizer that contains nitrogen and phosphorus is applied. If rainfall is inadequate or is poorly distributed, however, the response is not likely to be sufficient to justify the cost. Legumes grown in soils on old granitic sediment respond favorably if sulfur is applied.

CAPABILITY UNIT VIe-4 (18)

Soils in this unit are shallow, are moderately steep, and have low water-holding capacity. These soils are in the Fallbrook, Friant, Millerton, Tivy, and Vista series. The surface layer ranges from coarse sandy loam to loam Depth to weathered rock that limits root development and somewhat limits water penetration is about 10 to 20 inches

Slopes range from 9 to 45 percent, and if these soils are not protected, the erosion hazard is high Available water holding capacity ranges from 2.0 to 4.0 inches.

These soils are used for grazing, for wildlife habitat, and for recreation. If moisture is adequate, vegetation on these soils respond favorably to nitrogen and sulfur fertilizers.

CAPABILITY UNIT VIe-6 (19)

This unit consists of moderately deep, hilly or steep soils. These soils are in the Blasingame, Cibo, Coarsegold, Keefers, Trabuco, Tretten, Trimmer, and Wisheylu series. The surface layer ranges from fine sandy loam to clay, and the subsoil is fine sandy loam to clay The range includes cobbly soils. Weathered bedrock is at a depth of more than 18 inches.

Slopes are generally from 30 to 45 percent, though they are as little as 3 to 15 percent in places. The erosion hazard is moderate to high Past erosion is slight, and little erosion occurs if an adequate cover of plant residues is kept on the areas. Permeability of the subsoil is generally moderately slow to slow. Available water holding capacity is about 3.0 to 6.0 inches.

These soils are used for grazing. Growth of forage plants is generally good to very good. Selected areas on the less sloping soils are suitable for seeding to perennial grasses, and other areas are suitable for seeding to annual forage plants. Land clearing is feasible Plants on these soils respond favorably to nitrogen and phosphorus fertilizers.

CAPABILITY UNIT VIs-1 (19)

Soils in this unit are rolling and hilly, well drained, and very rocky. They are in the uplands and are more than 20 inches deep to weathered granitic material These soils are in the Ahwahnee, Auberry, Fallbrook, Sierra, and Vista series. Their surface layer is sandy loam or coarse sandy loam, and their subsoil ranges from coarse sandy loam to sandy clay loam Rock outcrops occupy from 10 to 25 percent of the surface area.

Slopes range from 3 to 30 percent. Permeability is moderately rapid to moderately slow. Available water holding capacity ranges from 3.0 to 7.0 inches.

These soils are not suited to cultivation, but they are well suited to grazing. Forage plants on these soils respond favorably to nitrogen and sulfur fertilizers and in a few places to phosphorus fertilizer.

CAPABILITY UNIT VIs-4 (18)

Soils in this unit are undulating to hilly, very rocky, and well drained. They are in the uplands and are about 10 to 20 inches deep over bedrock. These soils are in the Ahwahnee, Fallbrook, Millerton, and Vista series. The surface layer ranges from fine sandy loam to coarse sandy loam

Slopes range from 3 to 30 percent. The erosion hazard is slight to high, and the soils are slightly eroded These soils are moderately rapid to moderately permeable. The available water holding capacity ranges from 2.0 to 3.5 inches.

These soils are used for grazing. They dry up earlier in spring than similar deeper soils, and forage plants grow less well because of the rocks and stones. The outcrops do not restrict movement of livestock, but they limit the use of heavy equipment.

Adequate amounts of plant residues must be left on the surface of these soils to maintain productivity. Forage plants on all of the soils respond favorably to nitrogen. The response of forage plants to sulfur or phosphorus is favorable on most of the soils if rainfall is sufficient and is adequately distributed.

CAPABILITY UNIT VIe-8 (18)

Soils in this unit are well drained, moderately deep, very rocky, and undulating to hilly. They are more than 20 inches deep to weathered bedrock. These soils are in the Blasingame, Cibo, Tivy, and Wisheylu series. Their surface layer ranges from sandy loam to clay and overlies a subsoil that ranges from loam to clay.

Slopes range from 3 to 30 percent, but soils in this unit are relatively stable, and susceptibility to erosion is slight. These soils are moderately permeable to slowly permeable; their available water holding capacity ranges from 5.0 to 8.0 inches.

These soils are suited to grazing and will support perennial grasses.

Rocks limit but do not prohibit simple seedbed preparation. The response to nitrogen fertilizer, and in some places to phosphorus fertilizer, is favorable. Adequate amounts of plant residues must be left on the surface to maintain productivity and to help control erosion.

CAPABILITY UNIT VIe-9 (18)

Soils in this unit are hilly to steep, very rocky, and about 24 to 36 inches deep over weathered bedrock. These soils are in the Blasingame, Cibo, Trabuco, and Trimmer series. Their surface layer ranges from loam to clay, and their subsoil ranges from clay loam to clay.

Slopes range from 30 to 45 percent, and erosion hazard is moderate to high. Past erosion has been slight, and little erosion is likely if an adequate cover of plant residues is maintained. Permeability of the subsoil is generally moderately slow to slow, and available water holding capacity is about 4.0 to 6.0 inches.

The soils are well suited to grazing, and forage production is generally good to very good. When brush is a problem, type conversion is feasible. Some areas are suitable for seeding to perennial grasses, and other areas are suitable for seeding to annual forage plants. Favorable response to nitrogen fertilizer, and in some cases phosphorus fertilizer, can be anticipated.

CAPABILITY UNIT VIs-8 (18)

This unit consists of extremely stony, steep, well-drained soils on uplands. Stones cover 2 to 15 percent of the surface. These soils are 10 to 36 inches deep over serpentine bedrock. They are in the Blasingame, Delpiedra, and Fancher series. The surface layer is loam and the subsoil ranges from loam to clay.

Slopes range from 30 to 45 percent. The erosion hazard is high but past erosion is slight. Permeability is moderate to slow. Available water holding capacity ranges from 3.0 to 7.0 inches.

These soils are used for grazing. Because of the unfavorable ratio of calcium and magnesium, inherent fertility is low. Natural clusters of perennial grasses grow in places. Productivity of forage from annual grasses and forbs is fair. In places vegetation on these soils respond to nitrogen and phosphorus fertilizers.

CAPABILITY UNIT VIIe-1 (18)

Soils in this unit are steep to very steep, are well drained, and are 20 or more inches deep over weathered rock. These soils are in the Ahwahnee, Auberry, Blasingame, Coarsegold, Fallbrook, Sierra, Trabuco, Tretten, Trimmer, Vista, and Wisheylu series. The surface layer ranges from loam to coarse sandy loam, and the subsoil ranges from coarse sandy loam to light clay.

Slopes range from 30 to 70 percent, and erosion hazard is high. Permeability is moderately rapid to slow. Available water holding capacity ranges from 3.0 to 8.0 inches.

These soils are used chiefly for grazing. Most areas have a cover of grass and oak, but brush grows in some places. Management is needed that controls grazing and thus maintains an adequate vegetative cover on the areas.

CAPABILITY UNIT VIIe-6 (18)

This unit consists of steep to very steep soils that are about 10 to 20 inches deep over weathered bedrock. These soils are in the Blasingame, Friant, Millerton, Tivy, and Vista series. The surface layer ranges from coarse sandy loam to loam, and texture of the subsoil is coarse sandy loam to clay loam.

Slopes range from 30 to 70 percent. The Friant and Vista soils have slopes from 30 to 45 percent. The erosion hazard for all of the soils is high. Permeability is moderately rapid to moderately slow. Available water holding capacity ranges from 1.5 to 3.5 inches.

These soils are suited to grazing, to use as protected watershed, and to provide habitat for wildlife. Forage production is fair, but grasses generally dry up early in spring. Grazing should be regulated to allow regrowth of vegetation that protects the soil from erosion.

CAPABILITY UNIT VIIe-1 (22)

Aiken very rocky loam, 45 to 70 percent slopes, is the only soil in this capability unit. This soil is in the uplands. It is very steep and is more than 48 inches deep over weathered bedrock. The subsoil consists of clay.

The erosion hazard is high on this soil. Available water holding capacity is more than 9.0 inches. Reaction is slightly acid to medium acid. Permeability is slow.

These soils are used for limited grazing and browse. The steep slopes, many rocks and stones, and semidense cover of shrubs and trees hinder grazing. Seeding and fertilizing are not practical.

CAPABILITY UNIT VIIs-7 (17, 18)

Soils in this unit are extremely rocky or stony or are very cobbly. They are in the Cibo, Fallbrook, Hideaway, Porterville, Toomes, and Vista series. Outcrops of rock or stones generally cover from 25 to 50 percent of the surface; cobblestones make up 50 to 90 percent of the surface soil. Depth ranges from 5 to more than 60 inches and texture from sandy loam to clay. Slopes are 0 to 70 percent.

Because of the rocks and stones on the surface, these soils have limited value for grazing. They can be used

to provide feed and cover for wildlife and for watershed purposes.

CAPABILITY UNIT VII–8 (18)

This unit consists of steep to very steep soils that are very rocky or extremely rocky or are extremely stony. Rock outcrops cover 10 to 25 percent of the surface of most of the soils. Stones cover 2 to 15 percent of the surface of the extremely stony soils. Depth to weathered bedrock ranges from 15 to 48 inches. These soils are in the Ahwahnee, Auberry, Blasingame, Cibo, Delpiedra, Fallbrook, Fancher, Millerton, Sierra, Tivy, Tollhouse, Trabuco, Tretten, Trimmer, and Vista series. Also in this unit are the land types, Colluvial land and Rock land.

Slopes range from 30 to 70 percent. Runoff is rapid to very rapid, and erosion hazard is high to very high. Available water holding capacity is 2.0 to 6.0 inches.

These soils are used for grazing. Growth of forage plants is fair to very good. Grazing should be controlled to provide good cover of plants for protection from erosion.

CAPABILITY UNIT VIII–1 (17, 18)

Terrace escarpments make up this capability unit. This land type is steep to very steep and occupies long narrow areas. Erosion hazard is very high. Gullies, once started, can easily damage adjacent soils.

This land type has little value for farming. It is used to provide food and cover for wildlife and sites for homes and for recreation.

CAPABILITY UNIT VIII–4 (17)

In this unit are the land types Pits and Riverwash. These units are extremely cobbly and gravelly. They are subject to occasional overflow and to seepage.

These land types are not suited to farming, but they are suitable for wildlife and recreation uses. They are sources of sand, gravel, or rock for construction purposes.

CAPABILITY UNIT VIII–9 (18)

Soils in this unit are extremely rocky and very shallow. Rock outcrops cover 50 to 90 percent of the surface. Between the outcrops of bedrock is shallow, loamy soil material. Soils of the Tollhouse series are in this unit and the land types Basic igneous rock land and Granitic rock land.

These soils and land types have no value for farming. They are used mainly for wildlife, recreation, and watershed purposes.

Storie Index Rating

The soils of the Area are rated according to the Storie index (*20, 21*). This index expresses numerically the relative degree of suitability, or value, of a soil for general intensive agriculture. The rating is based on soil characteristics only and is obtained by evaluating such factors as depth, texture of the surface soil, density of subsoil, drainage, salts and alkali, and relief. Other factors, such as availability of water for irrigation, climate, and distance from markets, that might determine the desirability of growing certain plants in a given locality, are not considered. Therefore, in itself the index cannot be considered as an index of land value. The index rating is given in the "Guide to Mapping Units."

Four general factors are considered in the index rating. These factors are (A) the characteristics of the soil profile particularly permeability and soil depth; (B) the texture of the surface soil; (C) slope, and (X) other factors or limitations, such as nutrient level, flooding, drainage, salts and alkali, erosion, and microrelief. Each of these four general factors is evaluated on the basis of 100 percent. A rating of 100 percent expresses the most favorable, or ideal, condition, and lower percentage ratings are given for conditions that are less favorable for crop production.

The index rating for a soil is obtained by multiplying the four factors, A, B, C, and X; thus, any factor may control the final rating. For example, a soil may have an excellent profile justifying a rating of 100 percent for factor A; excellent texture of the surface soil justifying 100 percent for factor B; a smooth nearly level surface justifying 100 percent for factor C, but a high accumulation of salts of alkali that would give a rating of 10 percent for factor X. Multiplying these four ratings gives an index rating of 10 for this soil. The high accumulation of salts or alkali would dominate in determining the quality of the soil, render it unproductive for crops, and justify the low index rating of 10.

Natural Land Types

The soils of the Eastern Fresno Area are grouped in five major natural land types based upon their setting in the natural landscape and upon certain of their characteristics that are important to their use in farming (*2?*). These land types have been developed for use with the Storie Index rating and are given in the "Guide to Mapping Units." They put the index rating of one soil into clearer perspective with the index rating of other soils. This grouping of soils is useful to those interested in property appraisal and in planning use of the soils for such purposes as irrigation, agriculture, grazing, timber, and watershed management.

The five major physiographic land type groups are: A, alluvial fans and flood plains; B, basins; C, lower terraces; D, higher terraces; and E, uplands. Each of these groups is subdivided on the basis of texture of the surface soil and soil depth. Groups A through D are further subdivided on the basis of subsoil density, or permeability, and groups D and E are subdivided on the basis of slope. These land types are further modified by five factors (1) drainage, (2) salinity, (3) erosion, (4) fertility, and (5) microrelief. The degree of each factor is shown by a lower case letter. For example, B2 2m represents a soil in a basin that is deep, has a surface layer that is medium in texture, a moderately dense subsoil, and is moderately saline

or alkali. An outline giving a brief definition of each natural land type follows:

A. Alluvial fans or flood plains (generally smooth valley land).
  - A1. Medium-textured soils that have a deep, permeable profile.
    - A1–1f: Similar to A1, but only fair drainage.
    - A1–1f–2s: Similar to A1–1f, but slightly saline-alkali.
    - A1–1p: Similar to A1, but poorly drained.
    - A1–1p–2s: Similar to A1–1p, but slightly saline-alkali.
    - A1–1p–5ch: Similar to A1–1p, but channeled surface microrelief.
    - A1–2s: Similar to A1, but slightly saline-alkali.
  - A2. Medium-textured soils that have a moderately dense subsoil or substratum.
    - A2–1f–2s: Similar to A2, but only fair drainage and slightly saline-alkali.
    - A2–1o: Similar to A2, but subject to overflow.
    - A2–2s: Similar to A2, but slightly saline-alkali.
    - A2–2m: Similar to A2, but moderately saline-alkali.
  - A4. Deep, fine-textured soils that have a moderately dense subsoil.
    - A4–1f: Similar to A4, but only fair drainage.
  - A5. Coarse-textured soils that have a deep, permeable profile.
    - A5–1p: Similar to A5, but poorly drained.
    - A5–2s: Similar to A5, but slightly saline-alkali.
  - A6. Coarse-textured soils that have a moderately dense subsoil.
    - A6–2s: Similar to A6, but slightly saline-alkali.
  - A7. Gravelly or cobbly soils that have a deep, permeable profile.
  - A9. Medium-textured soils that rest on a hard or clayey substratum.
    - A9–1f: Similar to A9, but only fair drainage.
    - A9–1f–2s: Similar to A9–1f, but slightly saline-alkali.
  - A11. Coarse-textured soils that rest on a hard substratum.
  - A14. Miscellaneous nonagricultural land types.

B. Basin land (flat land generally in the lowest part of a valley).
  - B1. Medium-textured soils that have a deep, permeable profile.
    - B1–2s: Similar to B1, but slightly saline or saline-alkali.
    - B1–2m: Similar to B1, but moderately saline-alkali.
    - B1–3s: Similar to B1, but strongly saline-alkali.
  - B2. Medium-textured soils that have a moderately dense subsoil.
    - B2–2m: Similar to B2, but moderately saline-alkali.
    - B2–3s: Similar to B2, but strongly saline-alkali.
  - B3. Fine-textured soils that have a deep, permeable profile.
  - B9. Medium-textured soils that have a dense slowly permeable subsoil.
    - B9–2s: Similar to B9, but slightly saline.
    - B9–3s: Similar to B9, but strongly saline-alkali.
  - B10. Fine-textured soils that have a dense, slowly permeable subsoil.
    - B10–2s: Similar to B10, but slightly saline.
    - B10–2m: Similar to B10, but moderately saline.
    - B10–3s: Similar to B10, but strongly saline-alkali.
  - B13. Medium-textured soils that have a hardpan.
    - B13–2s: Similar to B13, but slightly saline-alkali.
    - B13–2m: Similar to B13, but moderately saline-alkali.
    - B13–3s: Similar to B13, but strongly saline-alkali.
  - B17. Miscellaneous nonagricultural land types.

C. Low terrace land (smooth to gently undulating older valley land).
  - C2. Medium-textured soils that have a moderately dense subsoil.
  - C4. Fine-textured soils that have a moderately dense subsoil.
  - C8. Cobbly soils that have a moderately dense subsoil.
  - C9. Medium-textured soils that have a dense clay subsoil.
  - C12. Cobbly soils that have a dense clay subsoil.
  - C13. Medium-textured soils that rest on a hardpan or hard substratum.
    - C13–2m: Similar to C13, but moderately saline-alkali.
  - C14. Fine-textured soils that rest on a hardpan.
    - C14–1o: Similar to C14, but subject to local flooding.
  - C16. Gravelly soils that rest on a hardpan.
  - C17. Miscellaneous nonagricultural land types and very cobbly soils.

D. High terrace land (generally smooth remnants of very old valley land).
  - D28. Generally gravelly or cobbly, gently sloping to moderately sloping soils that rest on a hardpan.
    - D28–4p: Similar to D28, but poor fertility.

E. Upland (soils formed through in-place weathering of underlying rock material).
  - E1. Medium-textured, undulating to hilly soils that are more than 2 feet deep.
  - E2. Fine-textured, undulating to hilly soils that are more than 2 feet deep.
  - E3. Coarse-textured, undulating to hilly soils that are more than 2 feet deep.
    - E3–3m: Similar to E3, but moderately eroded.
  - E4. Rocky or gravelly, undulating to hilly soils that are more than 2 feet deep.
  - E5. Medium-textured, undulating to hilly soils that are less than 2 feet deep.
  - E7. Coarse-textured, undulating to hilly soils that are less than 2 feet deep.
  - E8. Rocky or stony, undulating to hilly soils that are less than 2 feet deep.
  - E9. Medium-textured, steep to very steep soils that are more than 2 feet deep.
  - E10. Fine-textured, steep to very steep soils that are more than 2 feet deep.
  - E11. Coarse-textured, steep to very steep soils that are more than 2 feet deep.
  - E12. Rocky, steep to very steep soils that are more than 2 feet deep.
    - E12–4p: Similar to E12, but fertility is low.
  - E13. Medium-textured, steep to very steep soils that are less than 2 feet deep.
    - E13–3m: Similar to E13, but moderately eroded.
  - E15. Coarse-textured, steep to very steep soils that are less than 2 feet deep.
  - E16. Rocky, steep to very steep soils that are less than 2 feet deep.
    - E16–4p: Similar to E16, but fertility is low.
  - E17. Nonagricultural, extremely rocky land types.

Yield Predictions and Management Practices [1]

The yield estimates in this survey are based on information furnished by farmers, on observations made by the soil scientists who surveyed the Area, and on suggestions furnished by crop specialists in the Soil Conservation Service, the Agricultural Extension Service, and the California Agricultural Experiment Station. More information was available for some soils than for others. If little or no information was available for a particular soil or if the specified crop is not grown on the soil, yield estimates were made by comparison with similar soils.

Table 2 gives the yields of the principal crops grown in the Area, under an optimum level of management. The optimum level of management is the best management known, or the level of management that experience, field trials, and research findings indicate give the highest possible returns at the present time.

Several important limitations should be kept in mind when using the yield estimates in table 2. First, the figures are estimates, or predictions. Second, the figures are averages that may be expected over a period of years. In any given year, the yield may be considerably higher or lower than the average. Third, there is considerable variation within some soils, and these variations were considered in making the estimates.

The information on yields and management practices provided in this part of the survey will be most useful and helpful immediately upon release of this survey. New developments in crop breeding, control of insects and diseases, use of fertilizer, tillage, irrigation, and drainage may replace much of the information in this section. The latest information can be obtained from State and Federal publications or agricultural agencies.

Estimates of yields are of most use when the management practices under which such yields can be produced are specified. Tables 3 through 15 show, for each principal crop and for the soils of specific capability units, the combination of practices that will produce the yields given in table 2 for the optimum management. Tables 3 through 15 are useful only in relation to table 2. To use them, find in table 2 the crop, the name of the soil, and the estimated yield; then look at the appropriate one of tables 3 through 15 to learn the details of management. For example, it is estimated Hanford sandy loam, clay loam substratum, will produce 8 to 10 tons of alfalfa per acre under optimum management. This soil is in capability unit I-1. To find the combination of practices that will produce this amount of alfalfa, refer to table 3 Irrigated alfalfa, and look in the columns under group 1.

Practices and yields are given only for soils used for the crops specified at the time this survey was prepared. Absence of information indicates the crop is not commonly grown or it is not suited to that soil.

[1] CLARENCE U. FINCH, JR., conservation agronomist, Soil Conservation Service, assisted with the preparation of this section.

Although the soils of the Eastern Fresno Area differ in management needs, certain general practices apply to all the soils that are cultivated. Among the general practices discussed in the paragraphs that follow are use of a suitable conservation cropping system, management of crop residues, proper tillage methods, and irrigation water management.

Conservation cropping system.—A suitable conservation cropping system is one that includes soil improving crops and the use of management practices that offset soil depleting crops and deteriorating practices. A conservation cropping system is needed on such major soils as the Delhi, Fresno, Grangeville, Hanford, Merced, and San Joaquin, as well as on the other soils of the survey area.

A suitable cropping system includes such green-manure crops as grasses and legumes. In addition all crop residues are returned to the soil, proper tillage is used, adequate amounts of fertilizer are applied, and weeds, insects, and other pests are controlled.

Many kinds of cropping systems are used in the Eastern Fresno Area. A typical example is that used on Hanford fine sandy loam, where alfalfa is grown for 3 to 4 years, followed by 1 or 2 years of cotton and 1 year of barley or corn. Then all crop residues from the cotton, barley, and corn are returned to the soil, and only necessary tillage is done.

Crop residue management.—Leaving all plant residues in cultivated fields improves and protects the soil. The residues are incorporated in the soil or are left on the surface during that part of the year when the hazard of erosion is critical. The plant residues add organic matter to the soil, and thus help to keep the soil in good tilth. Because of the climate in the Eastern Fresno Area and the intensive farming practiced, the organic matter decays rapidly and must be constantly replenished. Such soils as the Delhi, Hesperia, Ramona, and San Joaquin, for example, need a steady, seasonal supply of organic matter to remain in good tilth. In this way soil compaction is minimized and water and air can readily penetrate the soil.

Crops that produce a large amount of residue, such as grain sorghum, corn, safflower, rice, and barley, should be included in a cropping system to offset those that produce little residue. Other excellent sources of organic matter are shredded prunings from orchards and vineyards, animal manures, and grasses and legumes grown as cover crops and green-manure crops. Much organic matter also is returned to the soil in irrigated pastures. Nitrogen fertilizer should be applied if dry residues are disked in before planting late in spring.

Proper tillage.—Proper tillage is necessary for preparing a good seedbed, eliminating weeds, incorporating crop residues, and obtaining favorable intake of water and air through the soil. Pointless running of heavy equipment over fields results in compaction of the soil. Frequent tillage destroys soil structure.

Soil compaction is a problem on most soils in the Eastern Fresno Area, and particularly on the Hanford, Hesperia, Grangeville, and San Joaquin soils. In some places compaction is a problem even on the coarse-

TABLE 2.—*Estimated average acre yields of*

[Absence of yield figure indicates that the soil is not suited to the crop

Soil	Irrigated			
	Alfalfa	Barley	Corn	Cotton
	Tons	*Tons*	*Tons*	*Bales*
Academy loam, 2 to 9 percent slopes				
Academy loam, 0 to 3 percent slopes		1.8-2.3		<1.75
Ahwahnee coarse sandy loam, 9 to 15 percent slopes				
Ahwahnee coarse sandy loam, 3 to 9 percent slopes				
Alamo clay				
Atwater loamy sand, 0 to 3 percent slopes	6-8	1.5-2.0	2.5-3.0	2.0-2.5
Atwater loamy sand, 3 to 9 percent slopes	6-8			1.75-2.0
Atwater loamy sand, moderately deep, 0 to 3 percent slopes	6-8	1.5-2.0	2.0-2.5	1.75-2.0
Atwater sandy loam, 0 to 3 percent slopes	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Atwater sandy loam, 3 to 9 percent slopes	8-10		2.5-3.0	2.0-2.5
Atwater sandy loam, clay substratum, 0 to 3 percent slopes	6-8	2.0-2.5	2.5-3.0	1.75-2.0
Atwater sandy loam, moderately deep, 0 to 3 percent slopes	6-8	2.0-2.5	2.5-3.0	2.0-2.5
Auberry coarse sandy loam, 3 to 9 percent slopes				
Auberry coarse sandy loam, 3 to 9 percent slopes, eroded				
Auberry coarse sandy loam, 9 to 15 percent slopes				
Auberry coarse sandy loam, 9 to 15 percent slopes, eroded				
Blasingame clay loam, shallow, 9 to 30 percent slopes				
Blasingame loam, 3 to 15 percent slopes				
Borden loam	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Borden loam, saline-alkali	6-8	[1]1.5-2.0	[1]2.0	1.75-2.0
Borden loam, moderately deep	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Borden loam, moderately deep, saline-alkali	6	[1]1.5-2.0	2.0	<1.75
Cajon loamy coarse sand, saline-alkali	6	<1.5	<2.0	<1.75
Cajon coarse sandy loam	6-8	<1.5	2.0-2.5	1.75-2.0
Cajon coarse sandy loam, saline-alkali	6	<1.5	<2.0	1.75-2.0
Cajon coarse sandy loam, moderately deep, saline-alkali	6	<1.5	2.0	1.75-2.0
Cajon loamy coarse sand	<6	<1.5	2.0-2.5	<1.75
Calhi loamy sand, 0 to 3 percent slopes	6-8	<1.5	2.0-2.5	2.0-2.5
Calhi loamy sand, 3 to 9 percent slopes	6-8			2.0-2.5
Calhi loamy sand, moderately deep, 0 to 3 percent slopes	6-8	1.5-2.0	2.0-2.5	2.0-2.5
Centerville clay, 0 to 3 percent slopes		2.0-2.5	2.5-3.0	1.75-2.0
Centerville clay, 3 to 15 percent slopes				
Centerville cobbly clay, 3 to 9 percent slopes				
Centerville cobbly clay, 9 to 30 percent slopes				
Chino loam	8-10	2.0-2.5	2.5-3.0	2.5
Chino fine sandy loam	8-10	2.0-2.5	2.5-3.0	[illegible]
Chino fine sandy loam, saline-alkali	[1]8-10	2.0-2.5	[1]2.5-3.0	2.5
Chino fine sandy loam, moderately deep, saline-alkali	[1]6-8	[1]2.0-2.5	2.5-3.0	2.0-2.5
Chino loam, saline-alkali	[1]8-10	2.0-2.5	2.5-3.0	2.5
Chino sandy loam	8-10	2.0-2.5	2.5-3.0	2.5
Chino sandy loam, saline-alkali	8-10	[1]2.0-2.5	2.5-3.0	2.5
Chualar sandy loam, 0 to 3 percent slopes				
Chualar sandy loam, 3 to 9 percent slopes				
Cibo clay, 3 to 15 percent slopes				
Cibo clay, 15 to 30 percent slopes				
Coarsegold fine sandy loam, 9 to 15 percent slopes				
Cometa sandy loam, 3 to 9 percent slopes				
Cometa sandy loam, 9 to 15 percent slopes				
Cometa loam, 2 to 9 percent slopes				
Delhi loamy sand, 0 to 3 percent slopes	6-8		2.0-2.5	1.75-2.0
Delhi loamy sand, 3 to 9 percent slopes	6-8		2.0-2.5	1.75-2.0
Delhi loamy sand, moderately deep, 0 to 3 percent slopes	6-8		2.0-2.5	1.75-2.0
Delhi sand, 0 to 3 percent slopes	6		[illegible]	<1.75
Delhi sand, 3 to 9 percent slopes			<2.0	<1.75
Dello loamy sand			2.0-2.5	1.75-2.0
Dello sandy loam	6-8	1.5-2.0	2.0-2.5	1.75-2.0
El Peco fine sandy loam	8-10	2.0-2.5	[1]2.5-3.0	[1]2.0-2.5
El Peco loam	8-10	2.0-2.5	2.5-3.0	[1]2.0-2.5
El Peco sandy loam	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Exeter sandy loam	6-8	2.0-2.5	2.5-3.0	2.0-2.5
Exeter sandy loam, shallow		1.5-2.0	2.0-2.5	[1]1.75-2.0
Exeter loam	6-8	2.0-2.5	2.5-3.0	2.0-2.5
Fallbrook sandy loam, 3 to 9 percent slopes				
Fallbrook sandy loam, 9 to 15 percent slopes				
Fallbrook sandy loam, shallow, 3 to 9 percent slopes				
Foster sandy loam	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Foster loam	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Foster loam, saline-alkali				

principal crops under optimum management

specified or that the crop is not commonly grown; < = less than; > = more than)

Field crops					Irrigated fruit crops					
					Grapes					
Pasture (hay equiv.)	Rice	Sorghum (grain)	Sugar beets	Figs (dried)	Raisins	Wine	Table	Oranges	Peaches	Plums
Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
5.0-6.5				1.0-1.5				7.5-12.0		
5.0-6.5		2.0-2.5		1.0-1.5				7.5-12.0		
3.0-5.0										
3.0-5.0										
5.0-6.5										
3.0-5.0		2.5-3.0	16-22	1.0-1.5	2.0-2.5	6-8	3-5	5.0-7.5	8-12	5-6
3.0-5.0		2.0-2.5		1.0-1.5	2.0-2.5	6-8	3-5	5.0-7.5	8-12	6-9
3.0-5.0		2.0-2.5	16-22	1.0-1.5	2.0-2.5	6-8	5-7	5.0-7.5	<8	6-9
5.0-6.5		2.5-3.0	22-35	1.0-1.5	2.0-2.5	6-8	5-7	7.5-12.0	12-18	6-9
5.0-6.5		2.5-3.0	22-35	1.0-1.5	2.0-2.5	6-8	5-7	7.5-12.0	12-18	[illegible]
5.0-6.5		2.5-3.0	16-22		1.5-2.0	4-6	3-5			
5.0-6.5		2.5-3.0	22-35	1.0-1.5	2.0-2.5	6-8	5-7	5.0-7.5	8-12	6-9
3.0-5.0										
<3.0										
3.0-5.0										
<3.0										
3.0-5.0										
5.0-6.5										
[illegible]		2.5-3.0	22-35	1.0-1.5	2.0-2.5	6-8	5-7	....	>8	5-6
¹5.0-6.5		2.0-2.5	16-22							
5.0-6.5		2.5-3.0	22-35	1.0-1.5	2.0-2.5	6-8	5-7			5-6
¹5.0-6.5		¹2.0-2.5	¹<16							
<3.0		<2.0			<1.5	<4	<3			
3.0-5.0		2.5-3.0	<16		2.0-2.5	4-6	3-5			
3.0-5.0		2.0-2.5	<16		<1.5	<4	<3			
3.0-5.0		2.0-2.5	<16		<1.5	<4	<3			
<3.0		2.0-2.5			1.5-2.0	4-6	3-5			
<3.0		2.0-2.5	<16		1.5-2.0	4-6	3-5		...	...
		2.0-2.5								
<3.0		2.5-3.0	<16		2.0-2.5	4-6	3-5			
5.0-6.5		2.0-2.5	16-22					7.5-12.0		
5.0-6.5								7.5-12.0		
5.0-6.5								5.0-7.5		
3.0-5.0										
5.0-6.5	1.75-2.25	2.5-3.0	35		1.5-2.0	4-6	3-5			
5.0-6.5	1.75-2.25	2.5-3.0	35		1.5-2.0	4-6	3-5			
¹5.0-6.5	1.75-2.25	¹2.5-3.0	35		1.5-2.0	¹4-6	¹3-5			
¹5.0-6.5	1.75-2.25	¹2.5-3.0	22-35							
¹5.0-6.5	1.75-2.25	2.5-3.0	35		1.5-2.0	¹4-6	¹3-5			
5.0-6.5		2.5-3.0	22-35		1.5-2.0	4-6	3-5			
¹[illegible]		¹2.5-3.0	¹22-35		¹1.5-2.0	¹4-6	¹3-5			
5.0-6.5										
5.0-6.5										
5.0-6.5					......	....	......	5.0-7.5		
								5.0-7.5	...	
3.0-5.0										
5.0-6.5								7.5-12.0		
								7.5-12.0		
5.0-6.5								7.5-12.0	...	
<3.0		2.0-2.5	<16	<0.75	1.5-2.0	6-8	5-7		<8	6-9
<3.0		2.0-2.5	<16	0.75	1.5-2.0	6-8	5-7	...	<8	6-9
3.0-5.0		2.0-2.5	<16	<0.75	2.0-2.5	6-8	5-7		<8	6-9
<3.0		<2.0	<16		1.5-2.0	4-6	3-5		<8	5-6
<3.0		<2.0	<16		1.5-2.0	4-6	3-5		<8	5-6
<3.0		2.0-2.5	<16		1.5-2.0	4-6	3-5			
3.0-5.0		2.0-2.5	<16		1.5-2.0	4-6	3-5			
5.0-6.5		¹2.5-3.0	¹22-35							
¹5.0-6.5		¹2.5-3.0	¹22-35							
5.0-6.5		¹2.5-3.0	22-35							
5.0-6.5		2.0-2.5	16-22	1.0-1.5	2.0-2.5	6-8	>7	5.0-7.5	8-12	5-6
5.0-6.5		<2.0		0.75-1.0	1.5-2.0	4-6	3-5			
5.0-6.5		2.0-2.5	16-22	1.0-1.5	2.0-2.5	6-8	>7	5.0-7.5	8-12	5-6
3.0-5.0				...	......	....	......	5.0-7.5		
3.0-5.0								5.0-7.5		
3.0-5.0										
5.0-6.5		2.5-3.0	22-35		1.5-2.0	4-6	3-5			
5.0-6.5		2.5-3.0	22-35		1.5-2.0	4-6	3-5			
5.0-6.5										

TABLE 2.—*Estimated average acre yields of princi*

Soil	Irrigated			
	Alfalfa	Barley	Corn	Cotton
	Tons	*Tons*	*Tons*	*Bales*
Foster loam, moderately deep				
Foster loam, moderately deep, saline-alkali				
Fresno fine sandy loam	8-10	2.0-2.5	2.0-2.5	1.75-2.0
Fresno clay loam	6-8	1.5-2.0	<2.0	<1.75
Fresno fine sandy loam, shallow	6-8	2.0-2.5	2.0-2.5	1.75-2.0
Fresno sandy loam	8-10	2.0-2.5	2.0-2.5	1.75-2.0
Fresno sandy loam, shallow	6-8	2.0-2.5	2.0-2.5	1.75-2.0
Friant fine sandy loam, 9 to 30 percent slopes				
Grangeville fine sandy loam	8-10	2.0-2.5	3.0	2.5
Grangeville fine sandy loam, saline-alkali	8-10	2.0-2.5	2.5-3.0	2.5
Grangeville fine sandy loam, water table		2.0-2.5		
Grangeville fine sandy loam, water table, saline-alkali				
Grangeville fine sandy loam, gravelly substratum	6-8	2.0-2.5	2.5-3.0	
Grangeville fine sandy loam, hard substratum	6-8	2.0-2.5	2.5-3.0	2.0-2.5
Grangeville fine sandy loam, hard substratum, saline-alkali	6-8	2.0-2.5	2.0-2.5	1.75-2.0
Grangeville fine sandy loam, sandy substratum	6-8	2.0-2.5	2.0-2.5	1.75-2.0
Grangeville sandy loam	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Grangeville sandy loam, saline-alkali	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Grangeville sandy loam, sandy substratum	6-8	2.0-2.5	2.0-2.5	1.75-2.0
Grangeville soils, channeled				
Greenfield sandy loam, 0 to 3 percent slopes	10	2.5	3.0	2.5
Greenfield coarse sandy loam, 0 to 3 percent slopes	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Greenfield sandy loam, 3 to 9 percent slopes	8-10		2.5-3.0	2.0-2.5
Greenfield sandy loam, moderately deep, 0 to 3 percent slopes	6-8	2.5	3.0	2.0-2.5
Hanford fine sandy loam	10	2.5	3.0	2.5
Hanford coarse sandy loam	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Hanford coarse sandy loam, hard substratum	6-8	2.0-2.5	2.5-3.0	1.75-2.0
Hanford fine sandy loam, clay loam substratum	10	2.5	3.0	2.5
Hanford fine sandy loam, gravelly substratum	8-10	2.5	2.5-3.0	2.0-2.5
Hanford fine sandy loam, hard substratum	6-8	2.5	2.5-3.0	2.0-2.5
Hanford fine sandy loam, silty substratum	10	2.5	3.0	2.5
Hanford gravelly sandy loam	6-8	1.5-2.0	2.0-2.5	1.75-2.0
Hanford sandy loam	10	2.5	3.0	2.5
Hanford sandy loam, benches	6-8		2.0-2.5	2.0-2.5
Hanford sandy loam, clay loam substratum	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Hanford sandy loam, gravelly substratum	8-10	2.0-2.5	2.5-3.0	[illegible]-2.0
Hanford sandy loam, hard substratum	6-8	2.0-2.5	2.5-3.0	1.75-2.0
Hanford sandy loam, sandy substratum	6-8	2.0-2.5	2.0-2.5	1.75-2.0
Hanford sandy loam, silty substratum	10	2.5	3.0	2.5
Hesperia fine sandy loam, moderately deep	10	2.5	3.0	2.5
Hesperia coarse sandy loam	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Hesperia coarse sandy loam, saline-alkali	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Hesperia fine sandy loam	10	2.5	3.0	2.5
Hesperia fine sandy loam, saline-alkali	10	2.5	3.0	2.5
Hesperia fine sandy loam, moderately deep, saline-alkali	10	2.5	3.0	2.5
Hesperia sandy loam	10	2.5	3.0	2.5
Hesperia sandy loam, saline-alkali	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Hesperia sandy loam, moderately deep	10	2.5	3.0	2.5
Hesperia sandy loam, moderately deep, saline-alkali	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Hesperia sandy loam, shallow	6-8	2.0-2.5	2.0-2.5	1.75-2.0
Hesperia sandy loam, shallow, saline-alkali	6-8	2.0-2.5	2.0-2.5	1.75-2.0
Honcut fine sandy loam, 0 to 3 percent slopes	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Honcut fine sandy loam, 2 to 9 percent slopes				
Honcut fine sandy loam, gravelly substratum, 0 to 3 percent slopes				
Honcut fine sandy loam, hard substratum, 0 to 3 percent slopes	6-8	2.0-2.5	2.5-3.0	2.0-2.5
Keefer loam, 1 to 15 percent slopes				
Los Robles loam, 0 to 3 percent slopes	8-10		2.5-3.0	2.0-2.5
Los Robles clay loam, 0 to 3 percent slopes	8-10			2.0-2.5
Los Robles loam, 2 to 9 percent slopes				
Los Robles loam, hard substratum, 2 to 9 percent slopes				
Los Robles sandy loam, 2 to 9 percent slopes				
Los Robles sandy loam, gravelly substratum, 2 to 9 percent slopes				
Madera loam	6-8	2.0-2.5	2.5-3.0	2.0-2.5
Madera clay loam	6-8	2.0-2.5	2.0-2.5	1.75-2.0
Madera loam, saline-alkali	<6		<2.0	<1.75
Madera sandy loam	6-8	2.0-2.5	2.5-3.0	1.75-2.0
Merced clay, slightly saline		2.0-2.5	2.0-2.5	2.0-2.5
Merced clay		2.5	2.5-3.0	2.0-2.5
Merced clay, moderately saline		<1.5		1.75-2.0
Merced clay, saline-alkali				<1.75

pal crops under optimum management—Continued

Field crops				Irrigated fruit crops						
Pasture (hay equiv.)	Rice	Sorghum (grain)	Sugar beets	Figs (dried)	Raisins	Grapes: Wine	Grapes: Table	Oranges	Peaches	Plums
Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
5.0-6.5										
5.0-6.5										
[1]5.0-6.5	1.75-2.25	[1]2.0-2.5	16-22							
5.0-6.5	<1.75	[1]<2.0	[1]<16							
5.0-6.5	<1.75	[1]2.0-2.5	<16							
[1]5.0-6.5	1.75-2.25	[1]2.0-2.5	[1]16-22							
[1]5.0-6.5	<1.75	[1]2.0-2.5	[1]<16							
3.0-5.0										
5.0-6.5		2.5-3.0	35		1.5-2.0	>8	6-7	....	8-18	5-6
5.0-6.5		[1]2.5-3.0	[1]22-35		[1]1.5-2.0	[1]6-8				
<6.5										
3.0-5.0										
5.0-6.5		2.5-3.0	22-35		1.5-2.0	6-8	5-7			
5.0-6.5		2.5-3.0	22-35		1.5-2.0	6-8	5-7			
5.0-6.5		[1]2.0-2.5	[1]16-22							
5.0-6.5		2.0-2.5	16-22							
5.0-6.5		2.5-3.0	22-35		1.5-2.0	6-8	5-7			
[1]5.0-6.5		[1]2.5-3.0	22-35			[1]4-6				
5.0-6.5		2.0-2.5	16-22							
5.0-6.5										
5.0-6.5		3.0	22-35	1.0-1.5	2.5	>8	7	7.5-12.0	12-18	6-9
5.0-6.5		2.0-2.5	22-35	1.0-1.5	>2.5	6-8	5-7	7.5-12.0	12-18	6-9
5.0-6.5		2.5-3.0			2.0-2.5	6-8	5-7	7.5-12.0		
5.0-6.5		2.5-3.0	22-35	1.0-1.5	2.0-2.5	6-8	5-7	[1]5.0-7.5	8-12	5-6
5.0-6.5		>3.0	>35	>1.5	>2.5	>8	>7	[1]7.5-12.0	>18	>9
3.0-5.0		2.5-3.0	22-35	1.0-1.5	2.0-2.5	6-8	5-7	[1]7.5-12.0	8-12	6-9
3.0-5.0		2.5-3.0	16-22		2.0-2.5	6-8	5-7	5.0-7.5	8-12	5-6
>6.5		3.0	35	>1.5	2.5	>8	>7		12-18	6-9
5.0-6.5		2.5-3.0	22-35		2.0-2.5	6-8	5-7	[1]7.5-12.0	8-12	6-9
>6.5		2.5-3.0	22-35	1.0-1.5	2.0-2.5	6-8	5-7	[1]5.0-7.5	8-12	5-6
>6.5		>3.0	>35	>1.5	>2.5	>8	>7		>18	>9
3.0-5.0		2.0-2.5	16-22		2.0-2.5	6-8	5-7			
5.0-6.5		>3.0	>35	>1.5	>2.5	>8	>7	7.5-12.0	12-18	>9
3.0-5.0		2.0-2.5		1.0-1.5	2.0-2.5	6-8	5-7	7.5-12.0	8-12	6-9
5.0-6.5		2.5-3.0	22-35	>1.5	2.0-2.5	6-8	5-7		8-12	6-9
5.0-6.5		2.5-3.0	16-22		2.0-2.5	6-8	5-7	[1]7.5-12.0	8-12	6-9
5.0-6.5		2.5-3.0	16-22	1.0-1.5	2.0-2.5	6-8	5-7	5.0-7.5	8-12	5-6
5.0-6.5		2.0-2.5	16-22		2.0-2.5	6-8	5-7		8-12	5-6
>6.5		>3.0	35	>1.5	2.5	>8	>7		>18	>9
6.5		3.0	35		2.0-2.5	6-8	5-7		12-18	6-9
3.0-5.0		2.5-3.0	22-35		1.5-2.0	4-6				
[1]3.0-5.0		[1]2.5-3.0	[1]22-35		1.5-2.0	4-6				
5.0-6.5		3.0	35	1.0-1.5	2.0-2.5	6-8	5-7		12-18	6-9
[1]5.0-6.5		3.0	35		2.0-2.5	[1]6-8				
[1]>6.5		[1]3.0	[1]22-35							
5.0-6.5		>3.0	>35		2.0-2.5	6-8	5-7		12-18	6-9
[1]5.0-6.5		[1]2.5-3.0	[1]22-35		[1]2.0-2.5	[1]6-8				
5.0-6.5		3.0	35		2.0-2.5	6-8	5-7		12-18	6-9
[1]5.0-6.5		[1]2.5-3.0	[1]22-35							
5.0-6.5		2.0-2.5	16-22		1.5-2.0	4-6				
[1]5.0-6.5		[1]2.0-2.5	[1]16-22							
5.0-6.5		2.0-2.5			2.0-2.5	6-8	5-7	[1]7.5-12.0		
5.0-6.5										
3.0-5.0								5.0-7.5		
>6.5		2.0-2.5			2.0-2.5	6-8	5-7	[1]5.0-7.5		
5.0-6.5										
5.0-6.5		2.5-3.0			2.0-2.5	6-8	5-7	[1]7.5-12.0		
>6.5								[1]7.5-12.0		
5.0-6.5								[1]7.5-12.0		
5.0-6.5										
3.0-5.0								[1]7.5-12.0	12-18	
3.0-5.0										
>6.5		2.5-3.0	22-35	1.0-1.5	2.0-2.5	6-8	5-7	[1]7.5-12.0	8-12	6-9
6.5		2.0-2.5	22-35	0.75-1.0	1.5-2.0	6-8	5-7	[1]5.0-7.5	8-12	5-6
[1]3.0-5.0		[1]<2.0								
5.0-6.5		2.5-3.0	16-22	1.0-1.5	2.0-2.5	6-8	5-7	[1]7.5-12.0	8-12	6-9
5.0-6.5	2.25-3.0	2.0-2.5	22-35							
5.0-6.5	>3.0	2.5-3.0	22-35							
[1]3.0-5.0	<1.75	[1]<2.0	[1]16-22							
[1]3.0-5.0	[1]<1.75	[1]<2.0	<16							

TABLE 2.—*Estimated average acre yields of princi*

Soil	Irrigated			
	Alfalfa	Barley	Corn	Cotton
	Tons	Tons	Tons	Bales
Merced clay loam		>2.5	2.5-3.0	2.0-2.5
Merced clay loam, slightly saline		2.0-2.5	2.0-2.5	2.0-2.5
Millerton fine sandy loam, 9 to 30 percent slopes				
Montpelier coarse sandy loam, 9 to 15 percent slopes				
Mt. Olive clay, 9 to 15 percent slopes				
Mt. Olive clay, 3 to 9 percent slopes				
Nord loam, saline-alkali	[1]8-10		[1]2.5-3.0	[1]2.0-2.5
Nord loam	8-10		2.5-3.0	2.0-2.5
Pachappa loam, moderately deep	8-10	>2.5	2.5-3.0	>2.5
Pachappa loam	>10	>2.5	>3.0	>2.5
Pachappa loam, saline-alkali	[1]8-10	[1]>2.5	[1]2.5-3.0	2.0-2.5
Pachappa loam, moderately deep, saline-alkali	[1]6-8	[1]2.0-2.5	[1]2.0-2.5	[1]1.75-2.0
Piper sandy loam, 0 to 9 percent slopes	[1]6-8	[1]1.5-2.0	[1]2.0-2.5	[1]1.75-2.0
Piper fine sandy loam, 0 to 9 percent slopes	[1]6-8	[1]1.5-2.0	[1]2.0-2.5	[1]1.75-2.0
Pollasky sandy loam, 9 to 15 percent slopes				
Pollasky fine sandy loam, 2 to 9 percent slopes				
Pollasky fine sandy loam, 9 to 15 percent slopes				
Pollasky sandy loam, 2 to 9 percent slopes				
Pond fine sandy loam	[1]6-8	[1]1.5-2.0	[1]2.0-2.5	[1]1.75-2.0
Pond fine sandy loam, moderately deep	[1]<6	[1]1.5-2.0	[1]<2.0	[1]1.75-2.0
Pond loam	[1]6-8	[1]1.5-2.0	[1]2.0-2.5	[1]1.75-2.0
Pond loam, moderately deep	[1]<6	[1]1.5-2.0	[1]<2.0	[1]1.75-2.0
Pond sandy loam	[1]6-8	[1]1.5-2.0	[1]2.0-2.5	[1]1.75-2.0
Pond sandy loam, moderately deep	[1]<6	[1]1.5-2.0	[1]<2.0	1.75-2.0
Porterville clay, 0 to 3 percent slopes			2.5-3.0	2.0-2.5
Porterville clay, 3 to 15 percent slopes				
Porterville cobbly clay, 3 to 15 percent slopes				
Positas gravelly loam, 3 to 9 percent slopes				
Ramona sandy loam	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Ramona loam	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Ramona loam, gravelly substratum	6-8			1.75-2.0
Ramona loam, hard substratum	6-8	2.0-2.5	2.0-2.5	1.75-2.0
Ramona sandy loam, hard substratum	6-8	2.0-2.5	2.0-2.5	1.75-2.0
Redding gravelly loam, 3 to 15 percent slopes				
Rocklin sandy loam, 3 to 9 percent slopes				
Rossi fine sandy loam		[1]1.5-2.0		[1]<1.75
Rossi clay loam		[1]1.5-2.0		[1]<1.75
Sandy alluvial land, leveled	6-8	1.5-2.0	2.0-2.5	1.75-2.0
San Joaquin loam, 0 to 3 percent slopes	6-8	2.0-2.5	2.0-2.5	2.0-2.5
San Joaquin sandy loam, 0 to 3 percent slopes	6-8	2.0-2.5	2.0-2.5	2.0-2.5
San Joaquin sandy loam, shallow, 0 to 3 percent slopes	<6	2.0-2.5	2.0-2.5	1.75-2.0
San Joaquin sandy loam, shallow, 3 to 9 percent slopes				
San Joaquin loam, gravelly substratum, 0 to 3 percent slopes	6-8			
San Joaquin loam, shallow, 0 to 3 percent slopes	<6	2.0-2.5	2.0-2.5	1.75-2.0
San Joaquin loam, shallow, 3 to 9 percent slopes				
Sesame sandy loam, 3 to 9 percent slopes				
Sesame loam, 3 to 9 percent slopes				
Sesame loam, 9 to 15 percent slopes				
Sesame sandy loam, 9 to 15 percent slopes				
Sierra sandy loam, 9 to 15 percent slopes				
Temple clay loam		>2.5	>3.0	>2.5
Temple clay		>2.5	2.5-3.0	>2.5
Temple clay loam, saline		[1]>2.5	[1]>3.0	[1]>2.5
Temple clay loam, saline-alkali		2.0-2.5	[1]2.0-2.5	2.0-2.5
Temple loam		>2.5	2.5-3.0	>2.5
Temple loam, saline		[1]>2.5	[1]>3.0	>2.5
Temple loam, saline-alkali		[1]2.0-2.5	2.0-2.5	[1]2.0-2.5
Tivy loam, 9 to 30 percent slopes				
Tivy loam, 3 to 9 percent slopes				
Trabuco loam, 9 to 15 percent slopes				
Trabuco loam, 15 to 30 percent slopes				
Traver sandy loam, moderately deep	[1]8-10	[1]2.0-2.5	[1]2.0-2.5	2.0-2.5
Traver sandy loam	[1]8-10	[1]2.0-2.5	[1]2.5-3.0	[1]2.0-2.5
Traver fine sandy loam	8-10	[1]2.0-2.5	2.5-3.0	[1]2.0-2.5
Traver fine sandy loam, moderately deep	[1]8-10	[1]2.0-2.5	[1]2.0-2.5	[1]2.0-2.5
Tretten fine sandy loam, 3 to 15 percent slopes				
Trimmer loam, 3 to 15 percent slopes				
Tujunga loamy sand, 0 to 3 percent slopes	6-8		2.0-2.5	1.75-2.0
Tujunga sand, 0 to 3 percent slopes				
Tujunga loamy sand, 3 to 9 percent slopes	6-8		2.0-2.5	1.75-2.0

pal crops under optimum management—Continued

field crops				Irrigated fruit crops						
					Grapes					
Pasture (hay equiv.)	Rice	Sorghum (grain)	Sugar beets	Figs (dried)	Raisins	Wine	Table	Oranges	Peaches	Plums
Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
5.0-6.5	>3.0	2.5-3.0	22-35							
5.0-6.5	2.25-3.0	2.0-2.5	22-35							
3.0-5.0										
3.0-5.0								5.0-7.5		
5.0-6.5								7.5-12.0		
5.0-6.5								7.5-12.0		
[1] >6.5		[1] 2.5-3.0								
>6.5		2.5-3.0						[1] 7.5-12.0		
>6.5		2.5-3.0	22-35		2.0-2.5	6-8	5-7			
>6.5		>3.0	35	0.75-1.0	2.0-2.5	6-8	5-7	[2] 7.5-12.0	8-12	5-6
[1] >6.5		2.5-3.0	22-35							
[1] >6.5		[1] 2.0-2.5	[1] 16-22							
[1] 3.0-5.0		[1] 2.0-2.5	[1] 16-22							
[1] 3.0-5.0		[1] 2.0-2.5	[1] 16-22							
5.0-6.5								[2] 5.0-7.5		
5.0-6.5				>1.5				[2] 7.5-12.0		
5.0-6.5								[2] 5.0-7.5		
5.0-6.5				>1.5				[2] 7.5-12.0		
[1] 5.0-6.5	1.75-2.25	2.0-2.5	16-22							
[1] 5.0-6.5	<1.75	[1] <2.0	[1] <16							
[1] 5.0-6.5	1.75-2.25	[1] 2.0-2.5	[1] 16-22							
5.0-6.5	<1.75	[1] <2.0	[1] <16							
[1] 5.0-6.5	1.75-2.25	[1] 2.0-2.5	16-22							
[1] 5.0-6.5	<1.75	[1] <2.0	[1] <16							
5.0-6.5		2.5-3.0	16-22					[2] >12.0		
5.0-6.5								[2] >12.0		
5.0-6.5								[2] 7.5-12.0		
<3.0										
5.0-6.5		2.5-3.0	22-35	>1.5	2.0-2.5	6-8	>7	[2] >12.0	12-18	6-9
5.0-6.5		2.5-3.0	22-35	>1.5	2.0-2.5	6-8	>7	[2] >12.0	12-18	6-9
5.0-6.5					2.0-2.5	6-8	5-7	7.5-12.0		5-6
5.0-6.5		2.0-2.5	16-22	1.0-1.5	2.0-2.5	6-8	5-7	[2] 7.5-12.0	8-12	5-6
5.0-6.5		2.0-2.5	16-22	1.0-1.5	2.0-2.5	6-8	5-7	7.5-12.0	8-12	5-6
<3.0										
5.0-6.5				1.0-1.5						
[1] 5.0-6.5	1.75-2.25	[1] 2.0-2.5	[1] <16							
[1] 5.0-6.5	1.75-2.25	[1] 2.0-2.5	[1] <16							
[1] <3.0		[1] 2.0-2.5	[1] <16							
5.0-6.5		2.0-2.5	16-22	>1.5	2.0-2.5	6-8	5-7	[1] 5.0-7.5	8-12	5-6
5.0-6.5		2.0-2.5	16-22	>1.5	2.0-2.5	6-8	5-7	[1] 5.0-7.5	8-12	5-6
5.0-6.5		2.0-2.5		1.0-1.5	1.5-2.0	4-6	5-7	[1] <5.0		
5.0-6.5										
5.0-6.5					2.0-2.5	6-8	6-7			
5.0-6.5		2.0-2.5	<16	1.0-1.5	1.5-2.0	4-6	5-7	5.0-7.5		
5.0-6.5										
5.0-6.5										
5.0-6.5										
5.0-6.5										
5.0-6.5										
3.0-5.0										
>6.5	2.25-3.0	2.5-3.0	>35							
>6.5	2.25-3.0	2.5-3.0	22-35							
[1] >6.5	2.25-3.0	[1] 2.5-3.0	[1] >35							
[1] >6.5	1.75-2.25	[1] 2.0-2.5	[1] 22-35							
>6.5	2.25-3.0	2.5-3.0	>35							
[1] >6.5	2.25-3.0	[1] 2.5-3.0	[1] >35							
[1] >6.5	1.75-2.25	[1] 2.0-2.5	[1] 22-35							
3.0-5.0										
3.0-5.0										
3.0-5.0										
3.0-5.0										
[1] 5.0-6.5		[1] 2.0-2.5	22-35							
[1] 5.0-6.5		2.5-3.0	[1] 22-35							
5.0-6.5		[1] 2.5-3.0	[1] 22-35							
[1] 5.0-6.5		[1] 2.0-2.5	[1] 22-35							
3.0-5.0										
3.0-5.0										
3.0-5.0		2.0-2.5	16-22		2.0-2.5	6-8	5-7	[1] 5.0-7.5	8-12	5-6
<3.0					<1.5	<4				
3.0-5.0		2.0-2.5			2.0-2.5	6-8	5-7		8-12	5-6

TABLE 2.—*Estimated average acre yields of princi*

Soil	Irrigated			
	Alfalfa	Barley	Corn	Cotton
	Tons	*Tons*	*Tons*	*Bales*
Tujunga loamy sand, gravelly substratum, 0 to 3 percent slopes			<2.0	<1.75
Tujunga pebbly loamy sand, 0 to 3 percent slopes				
Tujunga soils, channeled, 0 to 2 percent slopes				
Visalia sandy loam, 0 to 3 percent slopes	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Visalia sandy loam, 3 to 9 percent slopes				
Visalia sandy loam, clay loam substratum, 0 to 3 percent slopes	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Visalia loam, 0 to 3 percent slopes	8-10	2.0-2.5	2.5-3.0	2.0-2.5
Vista coarse sandy loam, 3 to 9 percent slopes				
Vista coarse sandy loam, 9 to 15 percent slopes				
Vista coarse sandy loam, shallow, 3 to 9 percent slopes				
Waukena fine sandy loam	------	[1]1.5-2.0	------	[1]<1.75
Waukena loam		[1]1.5-2.0		[1]<1.75
Wiasheylu loam, 3 to 9 percent slopes				
Wunjey silt loam	[1]8-10	[1]>2.5	[1]>3.0	[1]>2.5
Wunjey fine sandy loam	[1]8-10	[1]>2.5	[1]>3.0	[1]>2.5
Yokohl loam, 0 to 3 percent slopes	<6	------	------	<1.75
Yokohl loam, 3 to 9 percent slopes	<6			
Yokohl loam, moderately deep, 0 to 3 percent slopes	6-8	------	------	1.75-2.0
Yokohl loam, moderately deep, 3 to 9 percent slopes	6-8			
Yokohl gravelly loam, 3 to 9 percent slopes				
Yokohl clay loam, moderately deep, 0 to 3 percent slopes	6-8			1.75-2.0

[1] After content of salt and alkali is reduced through reclamation.

TABLE 3.—*Irrigated alfalfa*

GROUP 1: CAPABILITY UNITS I-1 (17 18), IIs-1 (17), IIs-9 (17), IIe-3 (17), AND IIs-4 (17)

Practices	Optimum management
Rotation	Alfalfa 4 years, barley, sorghum, or corn 1 year, cotton 1 or 2 years.
Seedbed preparation	Disk, rip (as necessary), disk, landplane, disk, springtooth, spike harrow, plant, roll.
Seeding:	
Variety	Moapa, Lahontan, certified.
Rate	15 to 20 pounds per acre broadcast; 12 to 15 pounds per acre when drilled in a well-prepared seedbed.
Date	October, November, February.
Fertilization	45 pounds of phosphorus per acre per year.
Irrigation:	
Method	Border on 0 to 3 percent slopes; sprinkler on 3 to 9 percent slopes.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 10-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	4.0 to 4.5 acre-feet.
Cutting schedule	6 cuttings.
Cutting state	At 0.1 bloom.
Insect control	Apply recommended insecticides as needed for control of damaging insects.
Conservation practices	Avoid working soils when wet; where feasible, combine tillage operations with seedbed preparation.

GROUP 2: CAPABILITY UNITS IIIs-4 (17) AND IVs-4 (17)

Practices	Optimum management
Fertilization	45 pounds of phosphorus per acre per year.
Irrigation:	
Method	Sprinkler or border.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally an 8-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	4.5 to 5.0 acre-feet.
All other practices	Same as for group 1.

GROUP 3: CAPABILITY UNITS IIs-3 (17) AND IIIs-8 (17)

Practices	Optimum management
Rotation	Alfalfa 2 to 4 years, cotton 1 year, barley, corn, or sorghum 1 year.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 6-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	4.5 to 5.0 acre-feet.
Conservation practices	Subsoil to a depth of 2.0 to 3.5 feet in soils that have a hardpan.
All other practices	Same as for group 1.

GROUP 4: CAPABILITY UNITS IIs-6 (17) AND IIIs-6 (17)

Practices	Optimum management
Rotation	Alfalfa 3 years, sugar beets 1 year, corn 1 year, barley 1 year.
Seedbed preparation	Disk, chisel, landplane, disk, landplane, springtooth, spike harrow, plant, roll.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 6-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	5.0 to 5.5 acre-feet.

pal crops under optimum management—Continued

field crops				Irrigated fruit crops						
Pasture (hay [illegible])	Rice	Sorghum (grain)	Sugar beets	Figs (dried)	Grapes: Raisins	Grapes: Wine	Grapes: Table	Oranges	Peaches	Plums
Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
3.0-5.0		<2.0			1.5-2.0	4-6	3-5		<8	
[illegible]3.0					2.0-2.5	6-8	3-5		8-12	5-6
4.0-5.0										
5.0-6.5		2.5-3.0	22-35	0.75-1.0	2.0-2.5	6-8	6-7	[1]7.5-12.0	12-18	6-9
5.0-6.5										
[illegible]6.5		2.5-3.0	22-35	0.75-1.0	1.5-2.0	6-8	5-7	[1]7.5-12.0	12-18	6-9
[illegible]		2.5-3.0	22-35	0.75-1.0	1.5-2.0	6-8	[illegible]	[illegible]-12.0	12-18	6-9
3.0-5.0								[1]5.0-7.5		
3.0-5.0								5.0-7.5		
[illegible]4.0								[1]<5.0		
3.0-5.0	1.75-2.25	[1]<2.0	<16							
[1]3.0-5.0	1.75-2.25	[1]<2.0	[1]<16	...	...		[illegible]	[illegible]		
5.0-6.5										
[1]>6.5		[1]>3.0	[1]>16		[1]1.5-2.0	[1]4-6	[1]3-5			
[1]6.5		>3.0	>16		[1]1.5-2.0	4-6	3-5			
5.0-6.5										
5.0-6.5										
[illegible]6.5		2.0-2.5		0.75-1.0	1.5-2.0	4-6	3-5	[1]5.0-7.5	8-12	5-6
5.0-6.5								[1]5.0-7.5		
5.0-6.5										
5.0-6.5		2.0-2.5		0.75-1.0	1.5-2.0	4-6	3-5	[1]5.0-7.5	<8	<5

[1] Based on location in an area where the frost hazard is relatively low.

TABLE 3.—*Irrigated alfalfa*—Continued

Practices	Optimum management
Conservation practices	[illegible] 5 to [illegible] feet; apply soil amendments as needed according to results of soil tests; apply additional water for leaching; provide drainage facilities for reclamation.
All other practices	Same as for group 1.

TABLE 4.—*Irrigated barley*

GROUP 1: CAPABILITY UNITS I-1 (17, 18), IIe-1 (17), IIs-0 (17), IIs-3 (17), IIw-2 (17), IIIs-3 (17), AND IIIs-8 (17)

Practices	Optimum management
Rotation	Alfalfa 3 years, cotton 1 or 2 years, barley 1 year.
Seedbed preparation	Disk twice, landplane, border or list, preirrigate, disk and harrow, plant.
Seeding:	
Variety	California Mariout, certified.
Rate	90 to 100 pounds per acre.
Date	November 15 to January 15.
Treatment	Fungicide such as Ceresan or Panogen.
Fertilization	60 to 80 pounds of nitrogen per acre per year.
Irrigation:	
Method	Border, furrow, or sprinkler; border or furrow on 0 to 3 percent slopes, sprinkler on 0 to 9 percent slopes.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 16-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	1.0 to 1.5 acre-feet.
Weed control	Spray as needed for control of harmful weeds.
Harvest	In June by combine.

Practices	Optimum management
Conservation practices	Return all crop residues to the soil where feasible, combine tillage operations with seedbed preparation; avoid working soils when wet; subsoil to a depth of 2.0 to 3.5 feet in soils that have a hardpan.

GROUP 2: CAPABILITY UNITS IIs-6 (17) AND IIIs-6 (17)

Practices	Optimum management
Rotation	Barley 1 year; milo, or corn, 1 year; cotton 2 years, pasture 5 years.
Seedbed preparation	Disk twice, chisel, landplane, border, preirrigate, disk and harrow, plant.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 14-day irrigation frequency is needed during period of maximum consumptive use.
All other practices	Same as for group 1.

GROUP 3: CAPABILITY UNITS IIIs-4 (17), IIIw-4 (17), AND IVs-4 (17)

Practices	Optimum management
Fertilization	60 to 100 pounds of nitrogen per acre per year.
Irrigation:	
Method	Sprinkler or border.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 7-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	1.0 to 1.5 acre-feet.
All other practices	Same as for group 1.

GROUP 4: CAPABILITY UNITS IIs-5 (17), IIIs-5 (17), AND IVs-5 (17)

Practices	Optimum management
Rotation	Alfalfa seed 3 years, sugar beets 1 year, cotton 1 year, barley 1 year.

TABLE 4.—*Irrigated barley*—Continued

Practices	Optimum management
Seedbed preparation	Same as for group 2.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 6-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	1.5 to 2.0 acre-feet.
Conservation practices	Return all crop residues to the soil; subsoil to a depth of 2.5 to 4.0 feet; apply soil amendments as needed, according to results of soil tests; apply additional water for leaching; provide drainage facilities for reclamation.
All other practices	Same as for group 1.

TABLE 5.—*Irrigated corn*

GROUP 1: CAPABILITY UNITS I-1 (17, 18), IIe-1 (17), IIs-0 (17), IIs-3 (17), IIs-4 (17), AND IIw-2 (17)

Practices	Optimum management
Rotation	Alfalfa 3 years, cotton 1 or 2 years, corn 1 year, barley 1 year.
Seedbed preparation	Disk, chisel, disk, springtooth, list, preirrigate, disk and harrow, plant.
Seeding:	
Variety	An adapted hybrid.
Rate	12 to 16 pounds per acre.
Date	April.
Treatment	Treat seed for soil-borne disease and insects.
Fertilization	100 to 150 pounds of nitrogen per acre per year.
Cultivation	2 shallow mechanical cultivations for weed control.
Irrigation:	
Method	Furrow on 0 to 3 percent slopes; sprinkler on 0 to 9 percent slopes.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 14-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.0 to 3.5 acre-feet.
Insect control	Apply recommended insecticides as needed for control of insects.
Harvest	Harvest by [illegible] mechanical cornpicker. Provisions for drying grain must be made if moisture content of grain is more than 15 percent.
Conservation practices	Return all crop residues to the soil; avoid working soil when wet; where feasible, combine tillage operations with seedbed preparation.

GROUP 2: CAPABILITY UNIT IIs-5 (17)

Practices	Optimum management
Rotation	Pasture 5 years, barley 1 year, corn 1 year, cotton 1 or 2 years.
Seedbed preparation	Disk twice, chisel, landplane, list or border, preirrigate, disk and harrow, plant.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 12-day irrigation frequency is needed during period of maximum consumptive use.
All other practices	Same as for group 1.

GROUP 3: CAPABILITY UNITS IIIs-4 (17), IIIw-1 (17), AND IVs-4 (17)

Practices	Optimum management
Seedbed preparation	Disk twice, springtooth, list, preirrigate, disk and harrow, plant.
Fertilization	120 to 150 pounds of nitrogen per acre.
Irrigation:	
Method	Sprinkler or furrow.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 4-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.5 to 4.0 acre-feet.
All other practices	Same as for group 1.

GROUP 4: CAPABILITY UNITS IIIs-2 (17) AND IIIs-8 (17)

Practices	Optimum management
Seedbed preparation	Disk, chisel, disk, list, preirrigate, harrow, plant.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 4-day irrigation frequency is needed during period of maximum consumptive use.
Conservation practices	Subsoil to a depth of 2.0 to 3.5 in soils that have a hardpan.
All other practices	Same as for group 1.

GROUP 5: CAPABILITY UNITS IIs-6 (17) AND IIIs-6 (17)

Practices	Optimum management
Rotation	Alfalfa 3 years, cotton 1 or 2 years, barley 1 year, sugar beets 1 year, sorghum or corn 1 year.
Seedbed preparation	Same as for group 2.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 4-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	4.0 to 4.5 acre-feet.
Conservation practices	Return all crop residues to the soil; subsoil to a depth of 2.5 to 4.0 feet; apply soil amendments as needed according to results of soil tests; apply additional water for leaching; provide drainage facilities for reclamation.
All other practices	Same as for group 1.

TABLE 6.—*Irrigated cotton*

GROUP 1: CAPABILITY UNITS I-1 (17, 18), IIe-1 (17), IIs-0 (17), IIs-3 (17), AND IIs-4 (17)

Practices	Optimum management
Rotation	Alfalfa 3 years, cotton 1 to 2 years, barley, corn, or sorghum 1 year.
Seedbed preparation	Disk, plow or disk, springtooth, list, preirrigate, harrow, plant; or precision tillage by disk, chisel, and list, preirrigate, shape beds, plant.
Seeding:	
Variety	Acala 4-42.
Date	April 1 to 15.
Treatment	Fungicide seed treatment.
Fertilization	80 to 120 pounds of nitrogen per acre per year.

TABLE 6.—*Irrigated cotton*—Continued

Practices	Optimum management
Cultivation:	
Thinning	Thin and weed by hand or mechanically
Mechanical	6 to 10 times, at a shallow depth for weed control
Irrigation:	
Method	Furrow on 0 to 3 percent slopes, sprinkler on 0 to 9 percent slopes
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 21-day irrigation frequency is needed during period of maximum consumptive use
Total amount	3.[illegible] to [illegible] acre-feet
Insect control	Inspect each week and apply recommended insecticides as needed for control of damaging insects.
Nematode control	Fumigate soil with a nematicide when needed
Harvest:	
Defoliation	Properly and effectively done generally by airplane.
Picking	Mechanically or by hand first picking October 1 to November 15; second picking November 15 to January 15.
Conservation practices	Return all crop residues to the soil where feasible, combine tillage operations with seedbed preparation; avoid working soils when wet.

GROUP 2: CAPABILITY UNIT IIs-5 (17)

Practices	Optimum management
Seedbed preparation	[illegible]
Fertilization	[illegible] per year
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 17-day irrigation frequency is needed during period of maximum consumptive use
All other practices	Same as for group 1.

GROUP 3: CAPABILITY UNITS IIIs-4 (17) AND IVs-4 (17)

Practices	Optimum management
Seedbed preparation	Disk or plow, disk, springtooth, list, preirrigate, harrow, plant, or precision tillage by disk, chisel and list, preirrigate, harrow, plant.
Fertilization	100 to 150 pounds of nitrogen.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally an 11-day irrigation frequency is needed during period of maximum consumptive use
Total amount	3.5 to 4.0 acre-feet
All other practices	Same as for group 1.

GROUP 4: CAPABILITY UNITS IIIs-3 (17) AND IIIs-8 (17)

Practices	Optimum management
Seedbed preparation	Disk, chisel, disk, list, preirrigate, harrow, plant.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 6-day irrigation frequency is needed during period of maximum consumptive use
Total amount	3.5 to 4.0 acre-feet.
Conservation practices	Subsoil to a depth of 2.0 to 3.5 feet in soils that have a hardpan.
All other practices	Same as for group 1.

GROUP 5: CAPABILITY UNITS IIs-[illegible] (17), IIIs-6 (17), AND IVs-[illegible] (17)

Practices	Optimum management
Rotation	Alfalfa seed 3 years, sugar beets 1 year, cotton 1 or 2 years, barley or sorghum 1 year
Seedbed preparation	Disk twice, chisel, landplane, disk, list, preirrigate, skid harrow, plant.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 6-day irrigation frequency is needed during the period of maximum consumptive use
Total amount	3.5 to 4.0 acre-feet
Conservation practices	Return all crop residues to the soil; subsoil to a depth of 2.5 to 4.0 feet; apply soil amendments as needed according to results of soil tests; apply additional water for leaching; provide drainage facilities for reclamation
All other practices	Same as for group 1.

TABLE 7.—*Irrigated pasture*

GROUP 1: CAPABILITY UNITS I-1 (17, 19), IIs-1 (17), IIs-0 (17), IIs-3 (17), AND IIs-4 (17)

Practices	Optimum management
Rotation	Irrigated pasture 5 years, barley 1 year, cotton 2 years.
Seedbed preparation	Disk twice, landplane, springtooth, border, level between border, harrow, cultipack, plant.
Seeding:	
Variety and rate	Certified seed planted per acre at a shallow depth as follows: 2 pounds alfalfa, or 3 pounds narrowleaf trefoil and 8 pounds Goars fescue, or 5 pounds Akaroa orchardgrass.
Date	October through November
Treatment	Innoculate legumes; treat grass seed with fungicide.
Fertilization	Apply 30 pounds phosphorus per acre per year, apply 120 to 150 pounds of nitrogen per acre per year, divided equally into 4 or 5 applications, apply just prior to irrigation or during irrigation.
Irrigation:	
Method	Border on 0 to 3 percent slopes, sprinkler on 0 to 9 percent slopes
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 12-day irrigation frequency is needed during period of maximum consumptive use
Total amount	4.0 to 4.5 acre-feet
Grazing management:	
New pastures	Mow at height of 4 inches to control weeds, graze when seeded grasses reach 8 inches in height; do not graze when fields are wet
Older pastures	Graze when pasture plants are 8 inches tall; do not graze closer than 4 inches in height or when fields are wet.

TABLE 7.—*Irrigated pasture*—Continued

Practices	Optimum management
Rotation	Divide pasture into three or more fields; 21 to 35 days allowed for regrowth.
Season	Maximum growth period April 15 to October 15, number of livestock reduced from October 15 to April 15.
Uniform growth	Mow as needed to control coarse stems and to maintain uniform growth, harrow as needed to scatter droppings.
Drainage	Provide drains to remove excess water at end of check; pump water back into system for recirculation.
GROUP 2: CAPABILITY UNITS IIs-5 (17), IIIe-5 (17), AND IIIw-5 (17)	
Seedbed preparation	Disk, chisel, landplane, springtooth, border, level between border, harrow, cultipack, plant.
Seeding:	
Variety and rate	Certified seed planted per acre at a shallow depth as follows: 2 pounds alfalfa, or 2 pounds Ladino clover and 8 pounds of Goars fescue.
Irrigation:	
Method	Border or sprinkler.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 10-day irrigation frequency is needed during period of maximum consumptive use.
All other practices	Same as for group 1.
GROUP 3: CAPABILITY UNITS IIIs-4 (17), IIIw-4 (17), AND IVs-4 (17)	
Seeding:	
Variety and rate	Certified seed planted per acre at a shallow depth as follows: 2 pounds alfalfa, or 3 pounds narrowleaf trefoil, and 8 pounds Goars fescue.
Irrigation:	
Method	Border or sprinkler.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a [illegible]-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	4.5 to 5.0 acre-feet.
All other practices	Same as for group 1.
GROUP 4: CAPABILITY UNITS IIIe-8 (17, 18), IIIs-3 (17), IIIs-8 (17), IVe-3 (17), IVe-4 (18), AND IVe-8 (18)	
Seeding:	
Variety and rate	Certified seed planted per acre at a shallow depth as follows: 2 pounds Ladino clover, or 3 pounds of narrowleaf trefoil and 8 pounds Goars fescue, or 5 pounds Akaroa orchardgrass.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 5-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	4.5 to 5.0 acre-feet.
All other practices	Same as for group 1.
GROUP 5: CAPABILITY UNITS IIs-6 (17), IIIs-6 (17), AND IVs-6 (17)	
Seedbed preparation	Disk, chisel, landplane, springtooth border, level between border, harrow, cultipack, plant.
Seeding:	
Variety and rate	Certified seed planted per acre at a shallow depth as follows: 5 pounds narrowleaf trefoil and 10 pounds Goars fescue.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 5-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	5.0 to 5.5 acre-feet.
Conservation practices	Subsoil to a depth of 2.5 to 4.0 feet; apply soil amendments as needed according to results of soil tests; apply additional water for leaching, provide drainage facilities for reclamation.
All other practices	Same as for group 1.

TABLE 8.—*Rice*

Practices	Optimum management
GROUP 1: CAPABILITY UNITS I-1 (17, 18) AND IIs-5 (17)	
Rotation	Rice 2 years, safflower 1 year, barley 1 year.
Seedbed preparation	Plow, disk and harrow twice, landplane twice, border, seed.
Seeding:	
Rate	150 pounds certified seed per acre.
Date	April 15 to May 15.
Treatment	Fungicide seed treatment.
Fertilization	80 pounds nitrogen per acre per year (use only ammonium form of nitrogen fertilizer).
Irrigation:	
Method	Contour basin, less than 0.3 of a foot fall between levees.
Water management and level	Maintain water level at 6 to 8 inches.
Total amount	7 acre-feet.
Insect control	Applied as necessary by aircraft.
Weed control	Selective herbicides applied as needed by aircraft to the growing crop or before plants emerge.
Harvest	In October by combine.
Conservation practices	Return all crop residues to the soil; grow a green-manure crop; where feasible, combine tillage operations with seedbed preparation.
GROUP 2: CAPABILITY UNIT IIs-5 (17)	
Rotation	Rice 2 years, cotton 2 years, barley 1 year.
Seedbed preparation	Disk, disk and harrow twice, landplane twice, border, seed.
Fertilization	70 pounds nitrogen per acre per year (use only ammonium form of nitrogen fertilizer).
Irrigation:	
Total amount	6 acre-feet.
All other practices	Same as for group 1.
GROUP 3: CAPABILITY UNITS IIIs-6 (17) AND IVs-6 (17)	
Rotation	Rice 2 years, cotton 1 year, sugar beets 1 year, barley 1 year.

TABLE 8.—*Rice*—Continued

Practices	Optimum management
Seedbed preparation	Same as for group 2.
Conservation practices	Return all crop residues to the soil; subsoil to a depth of 2.5 to 4.0 feet; apply soil amendments as needed according to results of soil tests; provide drainage facilities for reclamation.
All other practices	Same as for group 1.

TABLE 9.—*Irrigated sorghum grain*

GROUP 1: CAPABILITY UNITS I-1 (17, 18), IIe-1 (17), IIs-0 (17), IIs-3 (17), AND IIs-4 (17)

Practices	Optimum management
Rotation	Alfalfa 3 years, cotton 1 or 2 years, sorghum 1 year, barley 1 year.
Seedbed preparation	Disk twice, list or border, preirrigate, disk, harrow, plant.
Seeding:	
Variety	Adapted hybrid.
Rate	10 to 12 pounds per acre.
Date	May when single cropped; June 15 when double cropped.
Treatment	Treat seed for seedling disease and for damaging insects.
Fertilization	100 to 120 pounds of nitrogen per acre per year.
Cultivation	2 shallow mechanical cultivations for weed control.
Irrigation:	
Method	Furrow or border on 0 to 3 percent slopes; sprinkler on 0 to 9 percent slopes.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 17-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.0 to 3.5 acre-feet.
Harvest	Combine in November.
Conservation practices	Return all crop residues to the soil; avoid working soils when wet; where feasible, combine tillage operations with seedbed preparation.

GROUP 2: CAPABILITY UNIT IIs-5 (17)

Practices	Optimum management
Rotation	Pasture 5 years, barley 1 year, sorghum 1 year, cotton 1 or 2 years.
Seedbed preparation	Disk twice, chisel, landplane, list or border, preirrigate, disk, harrow, plant.
Irrigation:	
Method	Furrow, border, or sprinkler.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 16-day irrigation frequency is needed during period of maximum consumptive use.
All other practices	Same as for group 1.

GROUP 3: CAPABILITY UNITS IIIe-4 (17), IIIs-4 (17), AND IVs-4 (17)

Practices	Optimum management
Fertilization	120 to 150 pounds of nitrogen per acre per year.
Irrigation:	
Method	Furrow, border, or sprinkler.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a [illegible]-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.0 to 3.5 acre-feet.
All other practices	Same as for group 1.

GROUP 4: CAPABILITY UNITS IIIs-3 (17) AND IIIs-8 (17)

Practices	Optimum management
Seedbed preparation	Disk, chisel, disk, list or border, preirrigate, harrow, plant.
Irrigation:	
Frequency	Irrigate when [illegible] percent of the available moisture in the root zone has been used. Generally a 7-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.0 to 3.5 acre-feet.
Conservation practices	Subsoil to a depth of 2.0 to 3.5 feet in soils that have a hardpan.
All other practices	Same as for group 1.

GROUP 5: CAPABILITY UNITS IIs-6 (17), IIIs-6 (17), AND IVs-6 (17)

Practices	Optimum management
Rotation	Alfalfa seed 3 years, sugar beets 1 year, barley 1 year, sorghum 1 year.
Seedbed preparation	Same as for group 2.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 5-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.5 to 4.0 acre-feet.
Conservation practices	Return all crop residues to the soil; subsoil to a depth of 2.5 to 4 feet; apply soil amendments as needed according to results of soil tests; apply additional water for leaching; provide drainage facilities for reclamation.
All other practices	Same as for group 1.

TABLE 10.—*Irrigated sugar beets*

GROUP 1: CAPABILITY UNITS I-1 (17, 18), IIe-1 (17), IIs-0 (17), IIs-3 (17), AND IIs-4 (17)

Practices	Optimum management
Rotation	Alfalfa 3 years, sugar beets 1 year, cotton 1 or 2 years, barley 1 year.
Seedbed preparation	Disk, plow or disk, disk, landplane, list or border, preirrigate, cultipack, plant.
Seeding:	
Rate	6 pounds per acre.
Date	October to February.
Treatment	Treat seed with fungicide for soil-borne diseases.
Fertilization	120 to 150 pounds of nitrogen per acre per year.
Cultivation:	
Thinning	Mechanical or by hand.
Hand weeding	2 times.
Mechanical	4 to 6 shallow mechanical cultivations for weed control.
Irrigation:	
Method	Furrow on 0 to 3 percent slopes, sprinkler on 0 to 9 percent slopes.

TABLE 10.—*Irrigated sugar beets*—Continued

Practices	Optimum management
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 10-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.0 to 3.5 acre-feet.
Harvest	Mechanically August through November.
Conservation practices	Return all crop residues to the soil, avoid working soils when wet, where feasible, combine tillage operations with seedbed preparation.

GROUP 2. CAPABILITY UNIT IIs-[illegible] (17)

Practices	Optimum management
Seedbed preparation	Disk, plow or disk, chisel, disk, landplane, list or border, preirrigate, cultipack or harrow, plant.
Irrigation:	
Method	Furrow or sprinkler.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 15-day irrigation frequency is needed during period of maximum consumptive use.
All other practices	Same as for group 1.

GROUP 3. CAPABILITY UNITS IIIs-3 (17) AND IIIs-8 [illegible]

Practices	Optimum management
Seedbed preparation	Disk, chisel, disk, landplane, list or border, preirrigate, harrow, plant.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 7-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	[illegible] acre-feet.
Conservation practices	Subsoil to a depth of 2.0 to 3.5 feet in soils that have a hardpan.
All other practices	Same as for group 1.

GROUP 4. CAPABILITY UNITS IIs-6 (17), IIIs-6 (17) AND IVs-6 (17)

Practices	Optimum management
Rotation	Alfalfa seed 3 years, sugar beets 1 year, cotton 1 or 2 years, barley or sorghum 1 year.
Seedbed preparation	Disk, disk, chisel, landplane, list or border, preirrigate, skid harrow, plant.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 5-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.5 to 4.[illegible] acre-feet.
Conservation practices	Return all crop residues to the soil, subsoil to a depth of 2.5 to 4.[illegible] feet, apply soil amendments as needed according to results of soil tests, apply additional water for leaching, provide drainage facilities for reclamation.
All other practices	Same as for group 1.

TABLE 11.—*Irrigated figs (dried)*

GROUP 1: CAPABILITY UNITS I-1 (17, 18), IIe-1 (17), IIs-3 (17), IIs-4 (17), IIIe-6 (17), IIIs-3 (17), IIIs-4 (17), AND IIIs-8 (17)

Practices	Optimum management
Variety	Adriatic, Calimyrna, Mission, and Kadota.
Pruning	Selective pruning as necessary for thinning and branching; equipment clearance and removal of dead wood.
Fertilization	60 pounds of nitrogen per acre per year.
Cover crop:	
Variety and rate	Seed one of the following per acre: 20 pounds purple vetch, 40 pounds horsebeans, 8 pounds Cucamonga brome, 8 pounds Wimmera 62 ryegrass, or 30 pounds cereal grain.
Date	October thru November.
Insect control	Apply recommended [illegible] and [illegible] for control.
Cultivation	[illegible]
Irrigation:	
Method	Basin, border, and furrow on 0 to 3 percent slopes, sprinkler on 0 to 9 percent slopes.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 28-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	1.5 to 2.0 acre-feet.
Caprification	Pollination on the Calimyrna fig only, in June when figs reach [illegible] to [illegible] inch diameter and have a perfumed odor. Place 4 or 5 caprifigs per tree in bags every 3 to 5 days for period of 1 week using a total of 16 to 20 caprifigs per tree per season. The Adriatic, Mission, and Kadota figs [illegible] mature fruit without [illegible].
Harvest	August to September from the ground [illegible].
Conservation practices	Avoid working soils when wet, where feasible, [illegible] tillage operations, if feasible, subsoil to a depth of 2.0 to 3.5 feet in soils that have a hardpan.

TABLE 12.—*Irrigated raisin and wine grapes*

GROUP 1: CAPABILITY UNITS I-1 (17, 18), IIe-1 (17), IIs-0 (17), IIs-3 (17) AND IIs-4 (17)

Practices	Optimum management
Variety	Thompson seedless.
Fertilization	60 pounds of nitrogen per acre per year, phosphorus as needed.
Pruning	In winter when vine is dormant.
Shredding	Place prunings in alternate vine rows, then shred and disk into soil.
Cover crop:	
Variety and rate	Seed one of the following per acre: 20 pounds purple vetch, 40 pounds horsebeans, 8 pounds Cucamonga brome, 8 pounds Wimmera 62 ryegrass, or 30 pounds cereal grain.
Date	October through February, in alternate vine rows.

TABLE 12.—*Irrigated raisin and wine grapes*—Continued

Practices	Optimum management
Insect and disease control	Dust and spray as needed for control, generally 5 to 8 times a year.
Annual weed control in vine rows.	French plow or place weed control chemicals in a 4-foot band under vine row; use registered herbicides as preemergent spray in winter at suggested rates for primary weeds.
Cultivation	Disk after harvest; French plow or place weed control chemicals in vine row, disk prunings and cover crop; disk or springtooth and prepare for irrigation flat furrows; clip grass with rotary mower the balance of the season or disk or springtooth and prepare flat furrows for irrigation and repeat this operation every second or third irrigation for the balance of the season.
Irrigation:	
Method	Flat furrow on 0 to 3 percent slopes.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a [illegible]-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	[illegible] to 3.5 acre-feet.
Terracing	Grapes for raisins: prior to harvest prepare sloping terraces in vine rows to provide optimum condition for raisin drying; on east to west rows terrace to south; north-south rows can be leveled and [illegible].
Harvest	Grapes for raisins picked by hand in September and placed on trays for drying; wine grapes picked by hand and delivered to winery.
Drying for raisins	When top layer of grapes has browned and shriveled, turn upside down on trays; when two-thirds to three-fourths dry, [illegible] drying.
Conservation practices	[illegible]

GROUP 2.—CAPABILITY UNITS IIs-4 (17), IIIw-4 (17), AND IV[illegible] (17)

Practices	Optimum management
Fertilization	60 to 80 pounds of nitrogen per acre per year; phosphorus as needed.
Cover crop:	
Variety and rate	Seed one of the following per acre: 20 pounds purple vetch, 8 pounds Cucamonga brome, 4 pounds Blando brome, or 30 pounds cereal grain.
Annual weed control in vine rows	French plow in winter.
Cultivation	Disk after harvest; French plow; disk prunings and cover crop; disk or springtooth and prepare irrigation flat furrows; clip grass with rotary mower the balance of the season or disk or springtooth and prepare flat furrows for irrigation and repeat this operation every second or third irrigation for the balance of the season.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 10-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.5 to 4.0 acre-feet.
All other practices	Same as for group 1.

GROUP 3.—CAPABILITY UNITS IIIs-3 (17) AND IIIs-8 (17)

Practices	Optimum management
Cover crop:	
Variety and rate	Seed one of the following per acre: 20 pounds purple vetch, 8 pounds Cucamonga brome, 4 pounds Blando brome, or 30 pounds cereal grain.
Date	October through February in alternate vine rows.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 6-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.5 to 4.0 acre-feet.
Conservation practices	Subsoil to a depth of 3.0 to 4.0 feet in soils that have a hardpan.
All other practices	Same as for group 1.

GROUP 4.—CAPABILITY UNIT II[illegible] (17)

Practices	Optimum management
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 6-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.5 to 4.0 acre-feet.
Conservation practices	Apply soil amendments as needed according to amount of soil salts; apply additional water for leaching.
All other practices	Same as for group 1.

TABLE 13.—*Irrigated table grapes*

GROUP 1.—CAPABILITY UNITS I-1 (17, 18), IIs-1 (17), IIs-[illegible] (17), IIs-[illegible] (17), AND IIs-[illegible] (17)

Practices	Optimum management
Variety	Thompson seedless.
Fertilization	60 pounds of nitrogen per acre per year; phosphorus as needed.
Pruning	In winter when vines are dormant.
Shredding	Place prunings in alternate vine rows, then shred and disk into soil.
Cover crop:	
Variety and rate	Seed one of the following per acre: 20 pounds purple vetch, 40 pounds horsebeans, 8 pounds Cucamonga brome, 8 pounds Wimmera 62 ryegrass, or 30 pounds cereal grain.
Date	October through February in alternate vine rows.
Insect and disease control	Dust and spray as needed for control, generally [illegible] to 8 times a year.
Girdling	Selective girdling made after normal drop of the berry forms.
Thinning	As necessary for desired size and quality of grape and cluster.
Annual weed control in vine rows.	French plow or place weed control chemicals in a 4-foot band under vine row; use registered herbicides as preemergent spray in winter at suggested rate for primary weeds.
Cultivation	Disk after harvest; French plow or place weed control chemicals in vine row; disk prunings and cover crop; disk or springtooth and prepare

TABLE 13.—*Irrigated table grapes*—Continued

Practices	Optimum management
	permanent flat furrows; clip grass with rotary mower the balance of the season, or disk or springtooth and prepare flat furrows for irrigation and repeat this operation every second or third irrigation for the balance of the season.
Irrigation	
Method	Flat furrow on 0 to 3 percent slopes.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 24-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.0 to 3.5 acre-feet.
Harvest	Hand pick in August; haul to packing house.
Conservation practices	Avoid working soils when wet; where feasible, combine tillage operations.
GROUP 2: CAPABILITY UNITS IIIs-4 (17), IIIw-4 (17), AND IVs-4 (17)	
Fertilization	60 to 80 pounds of nitrogen per acre per year; phosphorus as needed.
Cover crop:	
Variety and rate	Seed one of the following per acre: 20 pounds purple vetch, 8 pounds Cucamonga brome, 4 pounds Blando brome, or 30 pounds cereal grain.
Annual weed control in vine rows.	French plow in winter.
Cultivation	Disk after harvest; French plow; disk prunings and cover crop; disk or springtooth and prepare permanent flat furrows; clip grass with rotary mower the balance of the season, or disk or springtooth and prepare flat furrows for irrigation and repeat this operation every second or third irrigation for the balance of the season.
Irrigation	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 10-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.5 to 4.0 acre-feet.
All other practices	Same as for group 1.
GROUP 3: CAPABILITY UNITS IIIs-2 (17) AND IIIs-8 (17)	
Variety	Emperor.
Fertilization	40 pounds of nitrogen per acre per year; phosphorus as needed.
Pruning	In winter when vine is dormant.
Shredding	Place prunings in alternate vine rows, then shred and disk into soil.
Cover crop:	
Variety and rate	Seed one of the following per acre: 20 pounds purple vetch, 8 pounds Cucamonga brome, 4 pounds Blando brome, 30 pounds cereal grain.
Date	In fall and late in winter in alternate vine rows.
Insect and disease control.	Dust and spray as needed for control, generally 5 to 8 times a year.
Annual weed control in vine rows.	French plow or place weed control chemicals in a 4-foot band under vine row; use registered herbicides as preemergent spray in winter at suggested rates for primary weeds.
Cultivation	Disk after harvest; French plow or place weed control chemicals in vine row; disk prunings and cover crop; disk and prepare permanent flat furrows; clip grass with rotary mower the balance of the season, or disk or springtooth and prepare flat furrows for irrigation and repeat this operation every second or third irrigation for the balance of the season.
Irrigation	
Method	Flat furrow on 0 to 3 percent slopes.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 6-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.5 to 4.0 acre-feet.
Coloring	Carefully remove leaves on lower part of north and east sides of vines for improved color up of fruit.
Harvest	Hand pick in October; haul to packing house.
Conservation practices	Subsoil to a depth of 3.0 or 4.0 feet in soils that have a hardpan; avoid working soils when wet; where feasible, combine tillage operations.
GROUP 4: CAPABILITY UNIT IIs-6 (17)	
Irrigation	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 6-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.5 to 4.0 acre-feet.
Conservation practices	Apply soil amendments as needed according to results of soil tests; apply additional water for leaching.
All other practices	Same as for group 1.

TABLE 14.—*Irrigated oranges*

GROUP 1: CAPABILITY UNITS I-1 (17, 18), IIe-1 (17), IIs-0 (17), IIs-3 (17), AND IIs-4 (17)

Practices	Optimum management
Variety	Washington navel and Valencia.
Pruning	Selective pruning as needed, primarily for dead wood.
Fertilization	100 pounds of nitrogen applied December to February; minor elements applied as needed.
Insect and disease control.	Suitable sprays or dust applied when needed.
Tilled groves:	
Cover crop:	
Variety and rate	Seed one of the following per acre: 20 pounds purple vetch, 8 pounds Cucamonga brome, or 8 pounds Wimmera 62 ryegrass.
Date	September through November.
Cultivation	Disk or springtooth, and prepare furrows for irrigation; repeat 2 or 3 times.
Nontilled groves:	
Furrows	Establish permanent broad based furrows for annual weed control with herbicides 3 years after trees have been field planted.

TABLE 14.—*Irrigated oranges*—Continued

Practices	Optimum management
Chemical weed control	Selective herbicides at suitable rates [illegible] for control of annual weeds; in orchards that are sprinkled, herbicide can be applied any time if followed by irrigation, spot spray with weed oil the rest of the year.
Irrigation:	
Method	Furrow on 0 to 3 percent slopes, sprinkler on 0 to 9 percent slopes.
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. [illegible]-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	2.5 to 3.0 acre-feet.
Frost protection	Wind machines or orchard heaters, or a combination of both needed, keep equipment ready for use and fuel supply adequate for 3 full nights.
Harvest	Hand harvest—navel oranges December through February, Valencia oranges April through June.
Conservation practices	Apply mulching material in weed-free, nontilled orchards on slopes of more than 4 percent; when wet, avoid orchard traffic and do not work soils.
GROUP 2. CAPABILITY UNITS IIs-5 (17) AND IIIs-5 (17)	
Fertilization	80 to 100 pounds of nitrogen per acre per year.
Cover crop:	
Variety and rate	Seed one of the following per acre: 20 pounds purple vetch, 6 pounds [illegible] ryegrass, or 4 pounds Blando brome.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. [illegible] irrigation frequency is needed during period of maximum consumptive use.
All other practices	Same as for group 1.
GROUP 3. CAPABILITY UNITS IIs-4 (17), IIIs-[illegible] (17), IIIs-[illegible] (17), AND IVs-4 (17)	
Fertilization	100 to 120 pounds of nitrogen per acre per year.
Cover crop:	
Variety and rate	Seed one of the following per acre: 20 pounds purple vetch, 8 pounds Cucamonga brome, or 30 pounds cereal grain.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. [illegible] irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.0 to 3.5 acre-feet.
All other practices	Same as for group 1.
GROUP 4. CAPABILITY UNITS IIIe-8 (17, 18), IIIs-3 (17), IIIs-8 (17), IVe-3 (17), AND IVe-8 (18)	
Cover crop:	
Variety and rate	Seed one of the following per acre: 20 pounds purple vetch, 8 pounds Cucamonga brome, or 4 pounds Blando brome.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally a 6-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.0 to 3.5 acre-feet.
Conservation practices	Subsoil to a depth of 3.0 to 4.0 feet in soils that have a hardpan.
All other practices	Same as for group 1.

TABLE 15.—*Irrigated peaches and plums*

Practices	Optimum management
GROUP 1. CAPABILITY UNITS I-1 (17, 18), IIe-1 (17), IIs-0 (17), IIs-3 (17), AND [illegible] (17)	
Pruning	Selective pruning in winter; shred and disk prunings into soil.
Fertilization	80 to 100 pounds of nitrogen per acre per year.
Cover crop:	
Variety and rate	Seed one of the following per acre: 20 pounds purple vetch, 40 pounds [illegible] Cucamonga brome, 8 pounds Wimmera ryegrass, or 30 pounds cereal grain.
Date	October through November.
Insect and disease control	Spray 3 or 4 times, depending upon [illegible], climate, kinds of insects and diseases.
Cultivation	Disk prunings and cover crop; disk, springtooth, and prepare out furrows for irrigation and repeat 4 times during season.
Irrigation:	
Method	Furrow, basin, border on 0 to 3 percent slopes; sprinkler on 0 to 9 percent slopes.
Frequency	Irrigate when [illegible] percent of the available moisture in the root zone has been used. Generally a 28-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	[illegible] to 3.0 acre-feet.
Thinning	Selective thinning, depending upon [illegible].
Harvest	Peaches July and August by hand, plums June 15 to July 15 by hand.
Conservation practices	Avoid working soil when wet, where [illegible] if feasible, rotary mow vegetative cover instead of disking.
GROUP 2. CAPABILITY UNITS IIs-4 (17), IIIw-4 (17), AND IVs-4 ([illegible])	
Fertilization	100 to 120 pounds of nitrogen per acre per year.
Cover crop:	
Variety and rate	Seed one of the following per acre: 20 pounds purple vetch, 8 pounds Cucamonga brome, or 30 pounds cereal grain.

TABLE 15.—*Irrigated peaches and plums*—Continued

Practices	Optimum management
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally an 18-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.0 to 3.5 acre-feet.
All other practices	Same as for group 1.
GROUP 3: CAPABILITY UNITS IIIe-8 (17), IIIs-8 (17), AND IIIs-8 (17)	
Cover crop:	
Variety and rate	Seed one of the following per acre: 20 pounds purple vetch, 8 pounds Cucamonga brome, 4 pounds Blando brome, or 30 pounds cereal grain.
Irrigation:	
Frequency	Irrigate when 50 percent of the available moisture in the root zone has been used. Generally an 8-day irrigation frequency is needed during period of maximum consumptive use.
Total amount	3.0 to 3.5 acre-feet.
Conservation practices	Subsoil to a depth of 3.0 to 4.0 feet in soils that have a hardpan.
All other practices	Same as for group 1.

textured Delhi soils, because those soils can be cultivated when moist.

In all tillage operations the farmers should (1) omit unnecessary or least essential tillage, (2) combine operations to reduce the number of trips over a field; and (3) delay tillage until the soil is dry.

Irrigation water management.—Irrigation water management is the controlling or regulating of the application of irrigation water in such a way that high crop production is obtained without wasting water or soil. It is needed on all soils in the area that receive irrigation water. Good irrigation generally means applying just enough water to fill the soil throughout the root zone in accordance to the needs of the crop and at a rate consistent with the intake characteristics of the soil and its erosion hazard.

In the Eastern Fresno Area irrigation water is applied by flooding, furrows, or sprinklers. The method used depends on the crop grown, the topography, the texture of the soil, and the preference of the operator. Alfalfa, grain, and pasture generally are irrigated by flooding the surface between two checks, or by sprinklers. Furrow irrigation or sprinklers are used on row crops, such as cotton, sugar beets, grain sorghum, and corn. Furrow irrigation is used in most orchards and vineyards. Low-set sprinklers are used in citrus groves.

To irrigate properly, the farmer must know the texture, structure, and depth of the soils, the depth to which the plant roots penetrate, and the water requirements of the crop. Most crops should be irrigated when 40 to 50 percent of the available moisture in the top half of the root zone has been used. A soil check should be made 48 hours after irrigation to determine if moisture was added to the desired depth.

If water is put on fine-textured soils, such as Merced and Porterville, too fast, it will run off the field. As a result water is wasted and may cause erosion. If water is put on too slowly, time and equipment is wasted and water is lost by evaporation. If too much water is applied to such soils as Calhi, Delhi, Grangeville, Hanford, and Hesperia, it will penetrate below the root zone or run off the field and be wasted. Continued overirrigation may drown out crops, cause disease, or create a drainage problem. On soils affected by salts, such as those of the Traver, Fresno, El Peco, and Pond series, the salts must be leached below the root zone periodically by controlled overirrigation. A good irrigation practice is to wet the soil to the root zone depth before planting annual crops and during the winter or spring when perennial crops are dormant.

Saline and Saline-Alkali Soils

Soluble salts in soils can be traced to several sources. Most of them had their origin in the decomposition of soil minerals and rocks through weathering processes. In humid regions, soluble salts are usually removed from the soil by percolating waters from rainfall. In arid regions, where the rainfall is low and evaporation is high, soluble salts remain within the soil and may accumulate sufficiently to restrict plant growth. In addition many low-lying areas receive salt-charged runoff or ground water. In areas that have a high water table, water may rise by capillary action and bring dissolved salts with it that accumulate within or at the surface of the soil as the moisture evaporates. Percolating water from seasonal rainfall modifies the location and the amount of salts that accumulate within the soil, but they do not remove the salts from the soil.

The effect of soluble salts on soils and plants depends upon the amount and composition of the salts present. If the proportion of calcium and magnesium is high and the proportion of sodium is low, the salts do not have a harmful effect on soil structure at any level of concentration, and the soils for the most part are fairly well aggregated, porous, and permeable. Large amounts of soluble salts, however, have a direct effect on plant growth. Soluble salts have a strong attraction for water, and plant roots have difficulty absorbing moisture from the soil if the amount of dissolved salts is excessive. For many plants this excess is 0.15 to 0.20 percent, by weight, of the air-dry soil. If the salt content becomes to high, water may even be withdrawn from the plant roots, and the plants will wilt and may die. Consequently, saline soils need more water than nonsaline soils to maintain plant growth. Strong concentrations of sodium also interfere with the uptake of calcium by plants.

A soil that contains excess soluble salts, is called a *saline* soil. The conductivity of a saturation extract from such a soil is more than 4 millimhos per centimeter at 25° C. In addition, less than 15 percent of the exchangeable bases on the clay particles consists of sodium. Ordinarily, a saline soil has a pH of less than 8.5 (*28*).

When the proportion of sodium to calcium and magnesium salts in the soil is high, an exchange of sodium for calcium and magnesium occurs on the surface of the clay particles. Clay that has a relatively high percentage of exchangeable sodium on the surface tends to be dispersed and to swell when wet. Pore space decreases, and permeability and aeration decrease. The particles are packed so closely together that the movement of water, air, and plant roots is restricted. Soils that have more than 15 percent of sodium on the surface of the clay particles are usually strongly alkaline to very strongly alkaline (reaction pH of 8.5 or higher) and are called *alkali soils*. The saturation extract from an alkali soil has a conductivity of less than 4 millimhos per centimeter at 25° C.

A soil that contains both excess soluble salts and alkali is said to be *saline-alkali* (28). Depending on the amount of salts and alkali, the effect on plant growth may be severe.

In the Eastern Fresno Area, the soils affected by salts are classed either as saline-alkali soils or saline soils. Some alkali soils occur, but they are not extensive. The alkali soils are associated with the saline-alkali soils in a complicated and generally spotty pattern. Sodium chloride and sodium carbonate are the principal salts that have accumulated in the saline-alkali soils. The salts in the saline soils are mainly sodium chloride and sodium sulfate.

The largest areas of soils affected by salts and alkali are in the basin and basin rim. Many small areas also are on broad alluvial fans of the rivers and on narrow flood plains of small entrenched streams near the edge of the foothills. In all areas of such soils, drainage is poor or somewhat poor because of a regional water table or because a perched water table is close to the surface. Initially the salts accumulated through the capillary rise and evaporation of the water over a long period of time. In some places the greatest concentration of salts is on the surface. In other places imperfect natural leaching from rainfall or from flooding or subsurface evaporation of rising waters has caused the salts to concentrate in horizons below the surface.

The affected soils in the basin formed under a regionally high water table that has since been lowered by pumping. Most of the affected soils on the basin flood plain are saline. The saline-alkali soils are on the basin rim and in other spots to the east.

These differences are a reflection of the character of the ground water. East of the valley trough, the water is very low in sulfate, is generally low in all dissolved solids, and contains some chlorides and bicarbonates. West of the trough, the ground water is much higher in dissolved solids, is high in sulfates, and contains some chlorides. The axial water underlying the basin flood plain is irregular in composition (15). Much of it is like the water on the west side of the trough in composition but is much lower in total dissolved solids.

About 168,500 acres within the Area has been classified as either saline or saline-alkali affected. Of this acreage the El Peco, Fresno, Piper, Pond, Rossi, Traver, Waukena, and Wunjey series comprise about 97,000 acres that characteristically are saline-alkali. The Borden, Cajon, Calhi, Chino, Foster, Grangeville, Hesperia, Madera, Nord, and Pachappa series include soils that are saline-alkali affected. They make up about 48,500 acres. About 23,000 acres consists of the Merced and Temple series, which are mainly saline. Some of the saline-alkali soils, particularly those of the Borden, Hesperia, and Pachappa series, are remnants of the encroachment of saline-alkali conditions after a local rise of the water table before the turn of the century. The rise was caused by overirrigation during the early days of development of surface-water irrigation systems using water from the Kings River (23). Consequently, when irrigating is done and if much water is imported from the California water system, care should be taken not to overirrigate.

Guidelines for reclamation of saline and saline-alkali soils

Field and laboratory determinations indicate that considerable variation in amounts of soluble salts and alkali in the soils may occur within short distances. Soil conditions vary so much it is not possible to make a general statement about the specific salts each soil contains, nor about the practices needed to improve any particular soil. Some general guidelines can be given, however, that should be helpful in dealing with the problem.

The key items to consider in planning a reclamation program are the following.

Water supply.—Ample supplies of water of good quality are a primary requirement. More water should be applied than is needed to grow crops that are established. The additional water is for leaching the salts downward into the lower part of the subsoil or below. The total dissolved salts in the water should be less than 1,200 parts per million, and the sodium percentage in relation to other dissolved bases should be less than 60 (28). Most of the ground water within the Area is of good quality and is readily available by pumping at moderate cost. In places, the water at a shallow depth is not suitable for long-term irrigation. If extensive reclamation is planned in the area of the basin rim, or if the content of salt is not known, a laboratory determination should be made.

General drainage.—Adequate drainage is needed to remove excess salts from the soil. Whatever the other conditions may be, improvement is likely only to that depth in the soil for which adequate drainage can be provided. The better the drainage, the more readily excess salts can be removed. If drainage is not adequate, and no measures are taken to improve it, little change is likely.

Rate of internal drainage.—Many factors affect downward movement of water through the soil: texture, bulk density, porosity, structure, and whether or not the soil shrinks or swells upon wetting and drying. The more rapid the rate of internal drainage, the more quickly excess salts can be removed and the sooner improvement can be obtained.

Uniform, medium to coarse textured soils that have favorable general drainage normally can be reclaimed

readily. Similar fine textured soils, such as those of the Merced series, can be improved only slowly or very slowly.

Many soils in the Eastern Fresno Area have a dense, slowly permeable subsoil or a cemented hardpan. Unless these soils are deep plowed and mixed, or ripped and broken, reclamation generally is not successful.

Amount of excess salts and alkali.—If general and internal drainage are adequate or are artificially improved, even severely affected saline soils can be readily improved by deep wetting alone. About all that is needed is the use of sufficient water to flush the salts downward.

Removing excess alkali is somewhat more difficult and expensive than removing excess salts, except in sandy soils such as the Calhi or Cajon. A chemical change must take place in the soil. This is generally brought about by applying gypsum (calcium sulfate). A soil test will show how much gypsum to use. Upon solution, gypsum supplies the calcium to replace the excess sodium on the surface of the clay particles. Generally not less than 5 tons of 60 percent gypsum ("pit gypsum," mined locally) is applied per acre. In strongly affected soils, as much as 15 to 20 tons per acre may be required. The needed calcium can also be obtained by applying sulfuric acid in bulk quantities. The acid reacts with the calcium carbonate prevalent in these soils. Both the calcium and the hydrogen ions from the acid work to displace the adsorbed sodium. The method often achieves quick results, but it is more expensive and extra care is needed in handling the acid. Elemental sulfur also can be used instead of gypsum, but sulfur takes longer to react. Before it can act, it must be changed to sulfate. This is done by microbes living in the soil. Much the same result is obtained using any of these materials, but time and cost differences should be considered.

Reclamation practices

On the basis of the foregoing guidelines, the saline and saline-alkali soils in the Eastern Fresno Area can be placed in the following general groups:

Soils very easy to reclaim.—In this group are deep, saline-alkali affected soils of the Cajon and Calhi series. The principal practices needed to improve these soils are deep wetting to remove the slight to moderate amounts of excess salts and, where needed, the application of small amounts of gypsum or sulfur to neutralize the alkali.

Soils easy to reclaim.—This group consists of deep, saline-alkali affected soils of the Foster, Grangeville, Hesperia, Nord, Pachappa, and Wunjey series. It also includes the moderately deep, saline-alkali affected member of the Cajon series. The principal practices needed to improve these soils are applying moderate amounts of gypsum or sulfur, plus deep wetting of the soils with excess amounts of water to leach the salts (including the displaced sodium); planting a crop that tolerates salts and alkali; and continuous use of irrigation water somewhat in excess of the requirements of the crop.

Soils somewhat difficult to reclaim.—In this group are deep, saline-alkali or saline affected soils of the Borden, Chino, Piper, Temple, and Traver series. Also included are the moderately deep, saline-alkali affected members of the Foster, Grangeville, Hesperia, and Pachappa series. The chief practices needed to improve these soils include leveling to control applications of irrigation water; deep chiseling of the moderately deep soils to improve internal drainage; applying moderate to large amounts of gypsum or sulfur, and where needed using split applications of gypsum to treat areas that are strongly affected; controlling flooding and deep leaching; establishing plants that tolerate salts and alkali.

Soils difficult to reclaim.—Moderately deep to shallow, saline-alkali affected soils of the Borden, Chino, El Peco, Fresno, Madera, Pond, and Traver series are in this group. Also in this group is the saline-alkali affected member of the Grangeville series that is moderately deep to the water table. The chief practices needed to improve these soils include leveling; deep ripping that shatters the hardpan or substratum and thus improves internal drainage; establishing drainage ditches or tile drains; applying large amounts of gypsum or sulfur to correct the alkali condition; applying water to leach excess salts downward; and establishing plants that tolerate salts and alkali.

Soils very difficult to reclaim.—In this group are very slowly permeable, saline or saline-alkali affected soils of the Merced, Rossi, and Waukena series. Anything more than very slow improvement of the upper layers of these soils is unlikely. The saline Merced soils are used for salt-tolerant crops. The saline-alkali soils of the Merced series are used for pasture or as sites for duck clubs. The Rossi and Waukena soils can be effectively reclaimed if deep chiseling is done that breaks up the restrictive layers in the soil profile before applying the common reclamation practices. Applying these practices, however, is expensive. Most of these soils are grazed, are used for irrigated pasture, or are used for rice. Results are relatively poor. All of the soils are well suited, however, as sites for duck clubs.

Assistance in interpreting laboratory data of soil and water tests and detailed reclamation schedules for various soil conditions can be obtained from the Fresno County Farm Advisors Office, or through the local offices of the Soil Conservation Service.

Use of the Soils for Range and Pasture [4]

The first part of this section discusses the 11 range sites in the Eastern Fresno Area. Then general management for three kinds of pasture is given.

Use of the soils for range

Soils in the Eastern Fresno Area that are used for range are too steep, too shallow, or too rocky for cultivated crops. They are suited, however, to production of forage year after year. About 355,000 acres in the eastern part of the survey area consists of range. The acreage extends from the San Joaquin Valley, at about

[4] By ROCHE D. BUSH, range conservationist, Soil Conservation Service.

400 feet elevation, to the boundaries of the National Forest, which vary in elevation from about 2,500 to 4,000 feet.

Because of their position, the swales included in all sites produce greater amounts of forage than the areas that surround them. The swales also remain green for a longer period of time late in spring and early in summer. They generally cannot be managed separately and, therefore, are treated as a part of each site.

At the lower elevations, the cover is mostly open grassland. When the average rainfall reaches about 16 inches, wedgeleaf ceanothus, mariposa manzanita, and other kinds of brush and such trees as blue oak, interior live oak, and California buckeye appear. Digger pine also occurs north of the Kings River. The trees and brush increase in density, and other species appear as rainfall increases. They contribute little livestock forage and generally detract from the potential production.

Most of the important forage plants in the Eastern Fresno Area are introduced. The original forage plants were a mixture of perennials and annuals, but the introduced plants are mostly cool weather annuals. The annuals furnish highly nutritious feed in spring when they are green and growing, but after maturity their nutritional value is low.

The forage consists of various mixtures of desirable, less desirable, and undesirable plants. Desirable plants include soft chess, filaree, annual clovers, burclover, wildoats, and remnant perennial grasses. Among the less desirable plants are ripgut brome, wild barley, annual fescues, red brome, wild carrot, and annual lupine. The undesirable plants include nitgrass, dogtail, tarweed, fiddleneck, popcornflower, vinegarweed, turkey mullein, star thistle, and a small amount of medusa head.

Where a range site is producing at or near its potential, a mixture of desirable plants make up 70 percent or more of the vegetative cover. Less desirable plants and undesirable plants make up the remaining cover. The undesirable plants do not amount to more than 10 percent of the total cover.

Livestock graze selectively. They seek out the more palatable and nutritious plants. If grazing is not carefully regulated, the more desirable plants are weakened or eliminated because they are not allowed to produce seed. Less desirable plants then increase. If grazing pressure is continued, even the second choice plants are thinned out or eliminated and undesirable, unpalatable plants take their place or the soil is left bare.

Each range site differs from other range sites in its ability to produce significantly different kinds and amounts of forage and in the management needed to keep the sites in good condition. For this management it is necessary to have knowledge of the soils that make up each site and of the kinds and amounts of plants the site can produce. Then it is possible to use management, including regulation of grazing, that favors production of the most desirable forage plants.

The 11 range sites in the Eastern Fresno Area are discussed in the following pages. The soils are listed and briefly described, the acreage and general location are given, and plants growing on the site are listed. In addition the total annual production without fertilization on an air-dry basis is estimated for each site. The estimate is based on a limited number of clippings and knowledge of the site. The total annual production of forage available for livestock also is discussed, though the figures are not to be interpreted as usable forage. Extremes in weather conditions can cause even greater fluctuations. Some of the soils have not been placed in a site, because they are not suited to range or are better suited to other uses.

Range site 1
Loamy (18 to 30 inch precipitation zone)

This site consists mainly of loams and fine sandy loams, some of which are rocky or very rocky. These soils are 20 to 48 inches deep to coarse-grained basic igneous, metamorphosed sedimentary, or metamorphosed basic igneous rock. Topography is undulating to very steep, but typically the slopes are dominantly less than 45 percent. Soils in this range site are in the Aiken, Coarsegold, Trabuco, Tretten, Trimmer, and Wisheylu series. This range site occupies about 47,000 acres and occurs at elevations between 2,000 and 4,000 feet.

Included are small areas of sandy loams and clay loams and of shallow phases of the soils in this site. Also included are less productive, extremely rocky areas and rock land areas.

The soils in this site have moderate to moderately high available water holding capacity. Permeability is moderate to moderately slow, runoff is medium to rapid, and fertility is moderate. These soils are slightly acid to neutral in reaction.

Some of the gently sloping soils are arable but are used for grazing. They should be considered first if improvements are planned.

When producing up to potential, the cover is open grass or grass and scattered oaks. Large acreages are covered with dense stands of brush or thickets of blue oak and live oak. Moderately good stands of burclover grow on this site. The forage is mostly soft chess, wildoats, and filaree, but blue wildrye and creeping wildrye grow in some places. Production of forage is improved by removing trees and brush in areas where heavy equipment can be operated safely. Forage plants respond well to applications of nitrogen and phosphorus fertilizers. Legumes respond to applications of sulfur fertilizer, particularly on the Coarsegold soils, but also on other soils of this site.

The total estimated annual production is 3,500 pounds per acre in years of favorable moisture, and 1,800 pounds per acre in years of unfavorable moisture. The total estimated annual production that would provide forage for livestock is 2,600 pounds per acre in years of favorable moisture and 1,500 pounds per acre in years of unfavorable moisture.

Range site 2
Granitic (18 to 30 inch precipitation zone)

In this site are sandy loams or coarse sandy loams, some of which are very rocky. These soils generally are more than 20 inches deep to weathered granitic bed-

rock. Topography is undulating to very steep, and slopes range from 3 to 70 percent. The slopes are dominantly less than 45 percent. Soils in this range site are in the Ahwahnee, Auberry, Holland, Shaver, and Sierra series. This site occupies about 107,000 acres and occurs at elevations between 2,000 and 4,000 feet. Some of the precipitation at the higher elevations comes in the form of snow that seldom remains on the ground for more than a few days.

Included are small acreages of shallow phases of these soils that are more droughty, and also some extremely rocky areas. These less productive areas make up less than 10 percent of the total area.

The surface layer is droughty, but these soils are deep enough to have moderate water-holding capacity. Fertility is moderately low, and runoff is moderate to rapid. If they are not adequately protected, these soils erode easily.

Some of these soils that are gently sloping are arable but are used for grazing. They should be considered first if improvements are planned.

When producing up to potential, the cover is open grass or grass with scattered oaks. Large acreages are covered with heavy stands of brush or dense stands of blue oak and live oak. Only a small amount of burclover grows on the site. The forage is mostly soft chess, wild oats, ripgut brome, and filaree. Production of forage is improved by removing trees and brush in areas where heavy equipment can be operated safely. Forage plants respond well to applications of nitrogen, phosphorus, and sulfur.

Total estimated annual production is 3,000 pounds per acre in years of favorable moisture and 1,400 pound per acre in years of unfavorable moisture. The total estimated annual production that would provide forage for livestock is 2,500 pounds per acre in years of favorable moisture and 1,000 pounds per acre in years of unfavorable moisture.

Range site 3
Clayey (12 to 16 inch precipitation zone)

This site consists of clays that are generally more than 20 inches deep. These soils formed in material from basic igneous rocks, from softly consolidated mixed terrace conglomerates, or from colluvium. Many areas are cobbly, stony, or rocky. Topography is gently sloping to steep. Slopes generally range from 3 to 45 percent, but some included areas have slopes that exceed 45 percent. Soils in this range site are in the Centerville, Cibo, Mt. Olive, and Porterville series. This site occupies about 19,000 acres and occurs at elevations between 400 and 2,000 feet.

The soils in this range site have moderate to high available water holding capacity. Permeability is slow to very slow, runoff is medium to rapid, and fertility is moderate to good. These soils are neutral to moderately alkaline in reaction, and may be slightly calcareous to strongly calcareous.

This site consists of open grassland range. The forage produced varies considerably. Burclover stands are very good, and during years of favorable moisture a major part of the forage consists of burclover. In years when moisture is favorable, a good amount of forage is grown. During drought years, however, barely enough forage is produced to maintain adequate organic residues. Forage yields can be increased on slopes where the increased production can be utilized by applying nitrogen-phosphorus-sulfur fertilizers.

The total estimated annual herbage production is 2,800 pounds per acre during years of favorable moisture, and 1,200 pounds per acre during years of unfavorable moisture. The total estimated annual production and the amount of forage available for livestock are the same because there is little brush and few trees on this site.

Range site 4
Loamy (14 to 18 inch precipitation zone)

This site consists mainly of loams, clay loams, and sandy loams, some of which are very rocky. These soils are more than 20 inches deep to coarse-grained basic igneous or metamorphosed basic igneous rock. Small areas are underlain by old granitic alluvium and have considerable clay in their subsoil. Topography is undulating to steep. Slopes range mainly from 3 to 70 percent, but most of these soils have slopes less than 45 percent. This range site consists of soils of the Blasingame and Chualar series and of the miscellaneous land type Colluvial land. It occupies about 20,500 acres in the foothills predominantly at elevations between 500 and 2,000 feet.

Included in this site are areas having rock outcrops and areas of rock land that have little or no potential for producing forage.

The soils in this range site have moderate to high water-holding capacity. Most soils are moderately permeable, but some have a slowly permeable subsoil. Fertility is moderate. Reaction is slightly acid to neutral.

Some of the gently sloping soils in this unit are arable but are used for range. They should be considered first if improvements are planned.

This site is largely open grassland range, but blue oak grows in some places. During years of favorable moisture, stands of burclover are moderately good and make up much of the forage. The rest of the forage is mostly soft chess, wildoats, and filaree. Brush is not a problem in managing this site. Forage crops on these soils respond significantly if nitrogen-phosphorus-sulfur fertilizers are added.

The total estimated annual production is 2,200 pounds per acre during years of favorable moisture, and 1,200 pounds per acre during years of unfavorable moisture. The total estimated annual production and the amount of forage available for livestock are the same because there is little brush and few trees on this site.

Range site 5
Shallow loamy (11 to 18 inch precipitation zone)

This site consists of clay loams, loams, and fine sandy loams that are 10 to 20 inches deep to coarse-grained basic igneous or metamorphosed basic igneous bedrock. Some areas are very rocky. Topography is undulating to steep, and slopes range mainly from 3 to 45 percent, but one-sixth of the included area has slopes in excess of 45 percent. Soils in this range site are in the Miller-

ton and Tivy series and shallow phases of the Blasingame series. This range site occupies about 20,500 acres in the lower foothills at elevations between 500 and 2,000 feet.

The soils in this site have low to very low water-holding capacity. Permeability is moderate to moderately slow, runoff is medium to very rapid, and fertility is moderate. Reaction is slightly acid to neutral.

This range site is almost entirely open grassland and a few scattered blue oaks. Moderately good stands of burclover grow on this site. The forage is mostly soft chess, wildoats, and filaree. The forage production is less than on soils of range site 4, because the soils are shallower and have lower water-holding capacity. Forage plants respond well to nitrogen-phosphorus-sulfur fertilizers when rainfall is well distributed during the growing season and when heavy equipment can be operated without damage to the soil. Brush is not a problem in managing this site.

The total estimated annual production is 2,000 pounds per acre in years of favorable moisture and 1,000 pounds per acre in years of unfavorable moisture. The total estimated annual production and the amount of forage available for livestock are the same because there is little brush and few trees on this site.

Range site 6
Granitic (14 to 18 inch precipitation zone)

This site consists of sandy loams, coarse sandy loams, and loams, some of which are very rocky or extremely rocky. These soils are more than 20 inches deep to weathered granitic rock. Some of these soils formed from semiconsolidated granitic sediment. Topography is undulating to steep, and slopes range mainly from 3 to 45 percent. This site is comparable to range site 2 except it occurs at lower elevations and has less rainfall, fewer trees, and less brush. Soils in this range site are in the Fallbrook, Montpellier, Pollasky, Rocklin, Sesame, and Vista series. This range site occupies about 63,000 acres and occurs at elevations between 500 and 2,000 feet.

The surface layer is droughty, and the soils generally have low water-holding capacity. Runoff is moderate to rapid, and fertility is moderately low. If these soils are not adequately protected, they erode easily.

Some of the gently sloping soils in this site are arable but are used for grazing. They should be considered first if improvements are planned.

Only limited amounts of burclover grow on this site, but many other annual legumes are present. The forage is mostly soft chess, wildoats, ripgut brome, and filaree. Forage plants respond well to applications of sulfur fertilizer. The fertilizer can be applied where heavy equipment can be operated safely.

Total estimated annual production is 2,500 pounds per acre in years of favorable moisture and 1,300 pounds per acre in years of unfavorable moisture. The total estimated annual production that would provide forage for livestock is 2,000 pounds per acre in years of favorable moisture and 1,000 pounds per acre in years of unfavorable moisture.

Range site 7
Shallow granitic (14 to 18 inch precipitation zone)

This site consists of sandy loams and coarse sandy loams that are 10 to 20 inches deep to granitic bedrock. Included are areas formed from mica schist and areas having rock outcrops. Topography is mainly undulating to steep, and slopes range from 3 to 45 percent. Soils of this site are intermingled with soils of range site 6. They are in the Fallbrook, Friant, and Vista series. This site occupies about 24,500 acres in the lower foothills at elevations between 500 and 1,500 feet.

The soils in this site are droughty and have very low water-holding capacity. Runoff is moderate to rapid, and fertility is moderately low. If these soils are not adequately protected, they erode easily.

This range site is almost entirely open grassland range with some scattered blue oak in the upper part of the site. Little or no burclover grows on this site. The forage is mostly soft chess, filaree, wildoats, and ripgut brome, but annual clover grows in the swales. Brush is not a problem in managing this site. The response of forage plants on these soils to fertilizer varies according to the amount and distribution of rainfall during the growing season.

The total estimated anual production is 1,600 pounds per acre in years of favorable moisture and 800 pounds per acre in years of unfavorable moisture. The total estimated production and the amount of forage available for livestock are the same because there is very little brush and few trees on this site.

Range site 8
Terrace (12 to 14 inch precipitation zone)

This site consists of soils having a surface layer of loam, sandy loam, or clay loam. Many of these soils are gravelly or cobbly. Most of them are 10 to 20 inches deep to a claypan or hardpan that restricts root growth and movement of water. Mostly the topography is nearly level to rolling, but some slopes are moderately steep. Slopes range from 2 to 30 percent. Typically this site has a hummocky or hogwallow microrelief. Soils in this range site are in the Academy, Alamo, Cometa, Keefers, Keyes, Madera, Positas, Redding, Rocklin, San Joaquin, and Yokohl series. This range site occupies about 17,000 acres. It occurs mostly in small valleys at the lower edge of the foothills and on the older terraces bordering valleys near the foothills.

The soils in this site are slightly acid to medium acid and have moderate to low water-holding capacity. Fertility is moderately low to very low, and runoff is slow to rapid.

The site is open, grass-covered range. The forage is mostly soft chess and filaree. A sparse growth of burclover is in the meandering swales and depressions containing Hildreth or Alamo clays. Where grazing has been heavy, considerable amounts of tarweed have invaded. Forage plants respond to nitrogen-phosphorus-sulfur fertilizers. The shallow San Joaquin, Rocklin, and Yokohl soils in this range site have a questionable response to fertilization because forage yields depend mainly on distribution and amount of rainfall during the growing season.

The total estimated annual production is 1,600 pounds per acre in years of favorable moisture and 1,000 pounds per acre in years of unfavorable moisture. The total estimated production and the amount of forage available for livestock are the same because there is little brush and few trees on this site.

Range site 9
Serpentine (16 to 22 inch precipitation zone)

The soils in this site are extremely stony loams derived from serpentine rock. Topography is hilly to very steep. Slopes range from 15 to 70 percent, but they are dominantly more than 45 percent. Soils in this range site are in the Blasingame, Delpiedra, and Fancher series. This site occupies about 18,000 acres. The areas are almost entirely north of the Kings River and north and west of Pine Flat Reservoir. The elevation ranges from 500 to 3,000 feet.

Included are areas of similar soils with many rock outcrops and a few landslide areas.

The soils in this site have low to moderate water-holding capacity. These soils are somewhat deficient in calcium, and fertility therefore is somewhat low. Permeability is moderate, and runoff is rapid to very rapid.

This range site is mostly open grassland but scattered blue oaks and wedgeleaf ceanothus grow on the higher lying north slopes. Little or no burclover grows on this site. Vegetative cover is sparse to moderate. Some wild oats grow on these soils, but in many places foxtail fescue and weedy plants that contribute little forage are dominant. Applying fertilizer generally is not practical, because of the very steep slopes.

The total estimated annual production is 1,400 pounds per acre in years of favorable moisture and 600 pounds per acre in years of unfavorable moisture. The total estimated production and the amount of forage available for livestock are the same because there is little brush and few trees on this site.

Range site 10
Extremely rocky

This site consists mainly of soils having a surface layer of loam, sandy loam, or coarse sandy loam. Rocks or stones cover 25 to 50 percent of the surface. The soils are generally 10 to 20 inches deep to metamorphic, basic igneous, basaltic, or granite bedrock. Topography is undulating to very steep, and slopes range from about 5 to 70 percent. In this range site are soils in the Auberry, Ahwahnee, Blasingame, Fallbrook, Hideaway, Millerton, Sierra, Tollhouse, Tivy, Toomes, and Vista series and the land type Rock land. This site occupies about 9,200 acres and occurs in small to moderate areas in the foothills.

The soils in this site are moderately permeable. Runoff is medium.

This range site is open grassland but also includes considerable brush and hardwoods. The number of rocks on and in the surface greatly influences forage production. Adding fertilizer is impractical.

The total estimated annual production is 1,800 pounds per acre in years of favorable moisture and 1,000 pounds per acre in years of unfavorable moisture. The total estimated annual herbage production that would provide forage for livestock is 1,500 pounds per acre in years of favorable moisture and 800 pounds per acre in years of unfavorable moisture.

Range site 11
Riverwash

This site consists of extremely variable soils that are remnants of mixed alluvial material on active flood plains. Most of these soils are shallow to deep to coarse sand and gravel and contain some loamy material. Some areas, however, consist only of coarse sand and gravel. The surface is rough and uneven but is nearly level in many places. Many areas are channeled. This range site consists of soils in the Grangeville and Tujunga series, and of the miscellaneous land types Riverwash and Swamp land. This site occupies about 9,000 acres. The areas are distributed throughout many parts of the survey area in long narrow tracts in stream channels and in swales.

Drainage and permeability are variable. Most of this site is subject to winter flooding. Because of location many areas receive sufficient moisture through subirrigation for the perennial vegetation present to remain green until late in summer.

Many areas of this site support a heavy stand of trees and brush with an understory of annual and perenial forbs and grasses. On other areas the vegetation is dominantly grasses and forbs. The trees and brush generally present are willow, alder, cottonwood, sycamore, blackberry, wild rose, poison oak, live oak, and valley oak. These trees and bushes contribute little to the usable forage. Desirable grasses and forbs that furnish the bulk of the forage include bluegrass, bermudagrass, blue wildrye, sedges, soft chess, annual clover, and filaree. Among the undesirable plants are stinging nettle, horehound, wormwood, curly dock, deergrass, and wiregrass.

The total annual forage production varies from as much as 2,000 pounds per acre to almost nothing, depending on the soils involved. It can vary a great deal within a short distance.

Use of the soils for pasture

The pasture in the Eastern Fresno Area is of three kinds, (1) irrigated pasture, on terrace and alluvial soils of the foothills and the San Joaquin Valley; (2) dryland pasture, produced on these same soils; and (3) alkali pasture, on nonirrigated valley soils, modified or affected by salts or alkali.

Pasture plants grow best on fertile, moderately fine textured loams and clay loams that have moderately high to high water-holding capacity. This is true both in irrigated and nonirrigated areas.

Irrigated pasture. Irrigated pasture in the Eastern Fresno Area consists either of annual grasses or of perennial grasses and legumes. Annual pasture made up of such grasses as sudangrass furnishes summer forage for livestock. Perennial pasture made up of various mixtures of grasses and legumes produces forage and also serves as a soil-improving crop in a crop rotation. The forage produced on both kinds of pasture is grazed, chopped for green feed, or cut for hay or silage.

Soil features considered in determining the kinds of grasses and legumes to be planted in perennial pasture are drainage, texture, fertility, tilth, slope, water-holding capacity, and salinity and alkalinity.

The seedbed generally is prepared and seeded in fall because the winter rains and cool weather favor establishment of a good stand. Before the seedbed is prepared and seeding is done, drainage and erosion need to be controlled. Use of a weed control program while the pasture is being established helps to get a good stand of pasture plants. After establishment, enough fertilizer should be added to maintain a high level of fertility.

Grazing management can influence the production and life of irrigated pasture. Grazing should not begin until after the pasture plants are well established. Then each year grazing can begin in spring when the grasses have reached a height of 8 to 10 inches. Divided pasture that permits grazing to be rotated and allows time for regrowth of plants and for irrigation cycles, produce more usable forage and last longer. Pasture should not be grazed when the soils are wet, especially pasture on fine-textured soils. If grazed when wet, the soils are compacted, tilth is destroyed, and yields of forage are reduced. For best growth pasture plants should not be grazed below a stubble height of 4 inches. Occasional mowing or clipping of rank growth after grazing helps maintain uniform growth, discourages selective grazing by livestock, and reduces clumpiness. Overgrazing irrigated pastures greatly reduces their ability to produce forage.

Dryland pasture. This pasture generally consists of small tracts of land that are intermingled with larger areas of range. It has good potential for forage production.

Dryland pasture consists of both annual and perennial plants. The annual plants are similar to those in annual range, and the perennial plants consist of alfalfa or of annual legumes planted with hardinggrass. Hardinggrass requires a minimum of 16 inches of rainfall annually and a moderately fine textured soil that has moderate water-holding capacity.

Management of annual pasture consists of seeding as necessary, adding fertilizer annually, and using proper grazing practices. Grazing should not begin until the plants are well established. Other practices are the same as those given in the discussion of range management.

Management of perennial pasture includes early grazing, a deferment period, and a late grazing period. The deferment period should coincide with the most nutritious and useful stage of annual growth. After the annuals dry up, the hardinggrass is still green and can be safely grazed.

Alkali pasture. This pasture is on the valley floor within the basin rim, in an area that does not receive sufficient rainfall to justify seeding or the applying of fertilizer. Some ranchers spread excess drainage water and winter runoff over parts of the area. In most places, however, the surface is rough and only low spots and swales are benefited. The amount of water that can be spread, and the length of time it remains on the surface has an effect on the kinds of plants that grow in a particular area. The vegetation varies considerably within a short distance, depending on the degree the soils are affected by salts or alkali.

Some of the most common plants on the higher and drier parts of the area are red brome, annual fescue, foxtail barley, filaree, and soft chess. In areas where the concentrations of salts and alkali are high, spikeweed, alkali heath, and saltgrass grow. These areas are interspersed with many barren slick spots. Saltgrass, wiregrass, and other forbs that tolerate salts and alkali grow in the swales and other low spots.

In years when rainfall is above average and is well distributed throughout the rainy season, a good amount of forage is produced. During cold dry winters, only the low spots and the swales receive enough moisture to produce usable forage. Areas of alkali pasture generally are grazed during winter and spring. Grazing also is done in summer where it has been possible to spread water.

Large acreages of soil used for alkali pasture are being reclaimed and used for irrigated crops. The rate at which these soils are reclaimed depends on the availability of good water, the feasibility of drainage, and the amount of salts and alkali present.

Wildlife[4]

Large herds of antelope and tule elk once roamed Fresno County, and the San Joaquin River had a fine run of salmon. These are now gone. The Area still has quite a variety of wildlife, however, and the potential for developing and maintaining it is good.

Most of the soils in the Area produce food and cover for many kinds of wildlife. Some kinds of wildlife like open areas near farms; others prefer brushy and wooded areas, and some require a water habitat.

A summary of the food and habitat needs of the more important kinds of wildlife in the Eastern Fresno Area follows.

Waterfowl.—Waterfowl are found chiefly in the basin areas and in the foothills near reservoirs. In the past, basin soils, such as the Merced, were flooded each winter and the areas furnished wintering habitat for many ducks, geese, and sandhill cranes. When these soils were reclaimed and planted to barley and rice, the crops were damaged considerably each year when the birds returned to their ancestral wintering grounds. This problem has largely been eliminated by establishing reserves, such as the Mendota Wildlife Management Area, where ample food and water are provided for the birds. Most of the birds use the refuge areas and leave the ricefields alone. In many years after the rice is harvested, winter rains may flood the fields and make them suitable habitats again for the birds.

Reservoirs in the foothills attract large numbers of Canada geese each year in winter. These birds fan out from the lakes to feed in pastures and on the stubble in fields on San Joaquin, Ramona, and associated soils of the low alluvial terraces; and on the Blasingame,

[4] By A. WENDELL MILLER, biologist, Soil Conservation Service.

Fallbrook, Vista, and other nearby grass areas on soils of the lower foothills.

Several duck clubs are in the county, chiefly on saline-alkali soils of the basin rim, such as those of the Fresno and Waukena series. Use of such soils for waterfowl habitat might be considered one of the best uses that those soils are capable of supporting. Shallow ponds generally can be built with a minimum of land leveling and the use of contour levees. The levees are put in at a contour interval of 0.3 of a foot up to as much as 1 foot. Water for the ponds is available from deep wells or from the Mendota Pool, but drainage water of poor quality (up to 5,000 parts per million of salt) can be used. Plants that are moderately salt tolerant, such as watergrass or millet and nodding smartweed, can be grown (*5*). Alkali bulrush is suited to soils that are extremely saline. It tolerates soil salinities up to about 70 millimhos (*16*).

The ducks that generally remain to nest in the Eastern Fresno Area are the wood duck, which nests chiefly along streams of the foothills, and the cinnamon teal. A few fulvous tree ducks also nest in the Area.

Pheasants.—Chinese ring-necked pheasant, an introduced bird, can be found throughout most cultivated areas of the Area. Moderate numbers of this bird live in the basin where rice is grown, on such soils as the Merced and Temple. An equal number frequent the young fans of the rivers, where crops such as alfalfa, sugar beets, corn, grain sorghum, and irrigated pasture are grown, on the Hanford, Hesperia, and associated soils. Growing a single crop on large tracts, clean cultivating, and the long dry summers in the Area tend to limit the number of pheasants. As a result, many pheasants are propagated on game farms and released to private individuals for hunting on property owned by pheasant clubs.

Quail.—Early farming practices in the county improved the habitat for valley quail, and their number increased considerably. The cereal grains planted by the farmers, as well as annual weeds, produced an abundance of seed for the quail. The orchards and vineyards set out by the farmers provided additional cover. As farming became more intensive, however, clean cultivating and the growing of a single crop on large tracts caused the habitat suitable for quail to dwindle. Now quail are throughout much of the survey area in scattered coveys. Some are even in the residential areas of the city of Fresno. Quail are most abundant in the chaparral of the upper foothills in areas of Ahwahnee, Auberry, Coarsegold, Sierra, Trimmer, and associated soils and along the streams in the valley.

Habitat can be developed successfully for quail on most soils in the survey area. Hedgerows of quailbush planted along canals and drainage ditches provide suitable habitat for quail on such basin soils as the Merced and Temple. Generally a supply of water and a few clumps of blackberries, multiflora rose, or quailbush are all that are needed to keep quail on a farm on the Chino, Grangeville, and associated soils of the recent alluvial fans and flood plains, and on Exeter, Ramona, and San Joaquin soils of the terraces. The woody plants should be placed near olive trees and other places where the quail like to roost. A place where drinking water can be obtained year-round should be provided.

On areas of oak and grass in the lower foothills, on such soils as the Fallbrook, Tivy, and Vista, dense ground cover and water are in short supply. In many places the oak can be harvested and the resulting brush placed in piles to provide cover for quail. The trunks of the trees can be sold for firewood. The small, loosely stacked brush piles generally last for 5 years, then the thinning process must be repeated. Water for quail can be provided by stock ponds, troughs, seeps, or springs. A brush pile or hedgerow must be placed nearby for protection.

In the upper foothills, where the average annual rainfall is 20 inches or more, brush is quite dense and extensive. Here such quail food as burclover, filaree, and fiddleneck are scarce but water is fairly abundant. The habitat can be improved for quail on brush-covered areas of Ahwahnee, Auberry, and Sierra soils by opening up the stands to make room for annual grasses, legumes, and forbs. Clearing strips 300 feet wide and leaving strips of brush 30 to 50 feet wide across the slope opens up the brushy areas. Generally it is more practical, however, to clear a field completely of brush, except for areas of rock outcrops. Then the brush can be placed in small, loose piles, and the excess piles can be burned. The remaining brush piles provide escape cover for quail. By the time the piles disintegrate, enough of the brush has sprouted to take care of the needs of the birds. On the cleared areas, 4 pounds of Blando brome and 15 pounds of Lana vetch per acre should be planted.

Mountain quail are in the uplands on such soils as the Holland, Shaver, Sierra, and Tollhouse. They generally frequent steep, brushy slopes and are not so readily managed as the valley quail.

Good quail hunting habitat is much in demand by hunters in the Area. The leasing of quail hunting rights of soils with well-developed quail habitat therefore can be a good source of income to a rancher or farmer.

Doves and pigeons.—Mourning doves frequent all parts of the survey area. They are most abundant in areas of Ramona and San Joaquin soils on old alluvial terraces, in areas of Blasingame, Fallbrook, Millerton, Tivy, and Vista soils in the low foothills; and in areas of Grangeville and Visalia soils along streams in valleys.

Bandtailed pigeons prefer the upper foothills, where the Auberry-Ahwahnee, the Coarsegold, and the Trimmer-Trabuco soil associations are located. In summer they nest in stands of conifers on soils of the Aiken, Holland, and Shaver series. In winter the number of bandtailed pigeons increases because migrants from further north come to the Area. They feed upon acorns, pine nuts, berries, and the like, and are likely to damage newly planted barley, young fruit trees, and grapes.

Deer.—California mule deer live mainly on the upland soils of the survey area, and a resident herd lives in the foothills where there is enough brush to give them cover. In winter migrants from higher elevations come in the upper reaches of the foothills. The Ahwahnee, Auberry, and Tollhouse soils support stands of brush that are much used by deer for winter range.

Important species in these stands are wedgeleaf ceanothus, birchleaf mountain-mahogany, mariposa manzanita, chaparral whitethorn, redbud, and flannelbush.

Mature stands of dense brush do not provide good habitat for deer. Most of the new growth is too high for the deer to reach, and few grasses and forbs grow in the understory. Dense stands are difficult for deer to penetrate, and if extensive, are a serious fire hazard. Brush control is needed.

In most areas in brush, suitable soils can be converted to grass or strips can be cleared in the brush to make the areas suitable habitat for deer. A few small patches of brush should be left standing. On steep slopes wide firebreaks, or browseways, are needed to break up large stands of brush and provide access routes.

Deer are a depredation hazard to farmers in the foothills. They like to browse in new orchards, vineyards, berry patches, and permanent pastures, or on Christmas tree farms. In establishing any of these, a deer-proof fence will be needed because it is nearly impossible to keep the deer from eating the lush, tender new growth.

Furbearers.—Within the survey area, mountain lion, black bear, and bobcat are at the higher elevations in the foothills. Coyotes are common in the foothills and in places on the basin rim on saline-alkali soils. They particularly prefer the undeveloped areas of Fresno, Pond, and Traver soils. Raccoons live along the watercourses, and ringtailed cats prefer wooded areas along streams and in the foothills. The opossum, an introduced species, and striped and spotted skunks live in both the valley and the foothills. Many skunks live in the entrenched valleys of rivers in areas of Grangeville and Hanford soils, as well as in areas of Tujunga soils and Riverwash. They are likely to carry rabies, and for this reason the areas they frequent are quarantined at times. Badgers prefer the valleys, especially areas on recent alluvial fans and flood plains. They also have been found in less intensively developed areas of Pollasky, Ramona, and San Joaquin soils of the terraces. Beavers live along some streams in the foothills, and a few of them live in the valley where they may damage canals and levees. Beaver can be taken at any time in the valley to prevent such damage. Muskrats, which only recently have been found in the Area, can also be taken at any time.

Ground squirrels are quite common throughout the survey area. They generally can be kept under control by the use of poison bait. The pocket gopher is also found throughout the survey area. This animal is most numerous on some of the San Joaquin soils near Pinedale where "mima mounds," or hogwallow microrelief, are particularly well developed (*9*). Owls, hawks, badgers, and other predators help to keep these rodents under control, though generally there are not enough predators to be effective. The most effective control measure on farmland is the use of a mechanical gopher-bait dispenser.

Many black-tailed jackrabbits frequent the valley lands of the Eastern Fresno Area. When natural predators, such as the coyote and golden eagle are lacking, these rabbits become overabundant and cause damage to alfalfa and to orchard crops. In some areas rabbit drives are necessary for control. The cottontail rabbit also is common in the Eastern Fresno Area but seldom becomes a nuisance. The western gray squirrel is in the upper wooded foothills on Aiken, Holland, Shaver, and Sierra soils, but the number generally is not large. The eastern fox squirrel is spreading slowly out into the Area from Roeding Park in the city of Fresno.

Birds.—Some of the more common birds in the survey area are the yellow-billed magpie, the mockingbird, the California jay, the California woodpecker, and, the western meadow lark. Brewer's blackbird and the house finch, or linnet, are also numerous. They may cause damage to fruit and seed crops and have to be controlled. A new arrival in the area is the starling. This bird is now quite common, especially in winter. It may become a serious pest in the orchards and vineyards. In the terraces and foothills, especially in winter, are many large hawks, such as the redtailed hawk and rough-legged hawk. These feed on ground squirrels, gophers, and jack rabbits that frequent rangeland. A few golden eagles also are seen. Turkey vultures are common throughout the Area.

Fish.—There are many farm ponds and reservoirs for irrigation and for watering stock in the Eastern Fresno Area. Many of these are stocked with largemouthed blackbass and bluegill or with redear sunfish and furnish food and recreation to many. The California Department of Fish and Game generally can supply the initial stock of bass and bluegill for such ponds. These fish can also be purchased from private breeders. Trout can be planted in ponds at the higher elevations of the foothills where the water temperature does not often rise above 70° F. These fish must be purchased, however, and they generally have to be restocked every other year.

Outdoor recreation—Millerton Lake, Pine Flat Reservoir, Lost Lake, Avocado Lake, and the Mendota Pool furnish good opportunities for fishing, boating, and swimming. In addition, the Area has several golf courses and community parks. The foothills of the Eastern Fresno Area have good potential for the development of such private recreational facilities as hunting and fishing clubs, campgrounds, and guest ranches.

Engineering Uses of the Soils[1]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, and pipelines, the foundations of buildings, facilities for storing water, structures for controlling erosion, drainage systems, and systems for disposing of sewage. The properties most important to the engineer are permeability, shear strength, compaction characteristics, soil drainage, shrink-swell characteristics, particle size, plasticity, and reaction. Also important are depth to water table, flooding hazard, depth to bedrock, to a hardpan or to

[1] By Arthur D. Dunkel and Don E. Dunham, engineers, Soil Conservation Service.

sand and gravel, and relief. Such information is made available in this section. Engineers can use it to—

1. Make soil and land use studies that will aid in selecting and developing sites for industries, businesses, residences, and recreational areas.
2. Make preliminary estimates of the engineering properties of soils in the planning of agricultural drainage systems, farm ponds, irrigation systems, land leveling, and diversion terraces.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, and cables, and in planning more detailed surveys for the selected locations.
4. Locate probable sources of sand, gravel, and other materials suitable for construction needs.
5. Correlate performance of engineering structures with mapping units to develop information for overall planning that will be useful in designing and maintaining certain engineering practices and structures.
6. Determine the suitability of the soils for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps and reports and aerial photographs.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

TABLE 16.—*Engineering*

[Tests performed by the Arcadia Materials Testing Laboratory of the U.S. Forest Service or by the California State Division ... indicates determination was not

Soil name and location[1]	Parent material	Arcadia Materials Testing Laboratory report number	California Division of Highways report number	Depth	Classification: AASHO[2]	Classification: Unified	Moisture: Maximum dry density
				Inches			*Lb. per cu. ft.*
Academy loam							
About 4,100 feet W. and 1,100 feet S. of junction of Academy and Herndon Avenues; SE¼ NW¼ NW¼ sec. 3, T. 13 S., R. 22 E.	Old, moderately consolidated mixed alluvium.		VI-62-2354	0–6	A-4(4)	CL-ML	126
			VI-62-2355	12–20	A-6(8)	CL	123
Ahwahnee coarse sandy loam.							
About 4½ miles, airline, NNW. of town of Auberry; near center NW¼ NE¼ sec. 19, T. 9 S., R. 23 E.	Quartz diorite.	2360–61		0–36	A-2-4(0)	SM	129
Auberry coarse sandy loam.							
Cut bank along Rush Creek Road, Haslett Basin, about 300 feet NW. of S¼ corner, sec. 15, T. 11 S., R. 25 E.	Quartz diorite.	2370		0–9	A-2-4(0)	SM	128
				9–50	A-4(1)	SC	134
				50–60	A-2-4(0)	SM	133
		....	....	60	A-1-b(0)	SW-SM	132
Borden loam:							
NW¼ NE¼ SE¼ sec. 14, T. 14 S., R. 19 E.	Granitic alluvium.		VI-59-154	0–4	A-4(3)	ML-CL	127
			VI-59-151	12–30	A-4(4)	CL	125
			VI-59-155	36–60	A-4(2)	SM	124
Coarsegold fine sandy loam.							
Cut bank along Trimmer Springs Road, SE¼ SE¼ sec. 9, T. 12 S., R. 25 E.	Quartz mica schist.	2371		0–8	A-4(6)	ML	129
				8–40	A-4(5)	ML	131
Delpiedra extremely stony loam.							
About ½ mile SE. of center of sec. 24, T. 12 S., R. 25 E.	Serpentine	2366		0–13	A-2-6(0)	GM	125
Delhi loamy sand							
700 feet E. and 40 feet N. of junction of Leonard and America Avenues; 700 feet E. and 40 feet N. of S¼ corner sec. 35, T. 14 S., R. 12 E.	Wind-sorted granitic alluvium.	.....	VI-62-2347	0–7	A-2-4	SM	120
Hanford fine sandy loam:							
About 400 feet S. and 35 feet W. of intersection of Southern Pacific spur line and Central Avenue, south of Sanger; NE¼ NW¼ sec. 35, T. 14 S., R. 22 E.	Granitic alluvium.		VI-62-2344	0–9	A-4(4)	ML	
		.....	VI-62-2345	18–40	A-4(5)	ML	

It should be emphasized that the interpretations made in this soil survey may not eliminate the need for sampling and testing needed at a site chosen for a specific engineering work that involves heavy loads or at a site where excavations are to be deeper than the depths of the layers here reported. Also, engineers should not apply specific values to the estimates for bearing capacity given in this survey. Nevertheless, by using this survey, an engineer can select and concentrate on those kind of units most important for his proposed kind of construction, and in this manner, reduce the number of samples taken for laboratory testing and complete an adequate soil investigation at minimum cost.

The soil mapping units shown on the maps in this survey may include small areas of a different soil material. These included soils are too small to be mapped separately and generally are not significant to the agriculture in the area but may be important in engineering planning.

Information of value in planning engineering work is given throughout the text, particularly in the sections "Descriptions of the Soils" and "Formation and Classification of Soils."

Some of the terms used by the scientist may be unfamiliar to the engineer, and some words—for example, soil, clay, silt, and sand—may have a special meaning in soil science. These and other special terms used in the soil survey are defined in the Glossary at the back of this survey. Most of the information about engineering is given in tables 16, 17, and 18.

test data

of Highways under agreement with the U.S. Bureau of Public Roads and the Soil Conservation Service. Absence of information made or that it was not applicable]

density [3]	Mechanical analysis														
	Percentage passing sieve—										Percentage smaller than—		Liquid limit	Plasticity index	Bulk density
Optimum moisture content	¾ inch	⅜ inch	No. 4	No. 8	No. 16	No. 30	No. 40	No. 50	No. 100	No. 200	0.005 mm	0.001 mm			
Percent															*Lb. per cu. ft.*
12				100	98	93		83	69	55	22	16	24	7	112
12				100	98	94		86	75	64	33	27	33	15	125
10			100				55			25	10		25	[4] NP	100
9		100	99				61			35	9		29	NP	94
8			100				69			38	18		30	8	121
8			100				49			20	9		27	NP	112
6			100				27			5	4		24	NP	125
11	-	-	-	100	99	98		85	67	51	18	8	21	5	106
12	---			100	92	98	--	81	75	55	24	11	23	9	112
10				- -	100	99		94	67	46	17	6	22	NP	112
9	100	99	94	--			84	-		65	13		23	NP	96
8	100	95	90	-	--	---	77	--	---	57	14	--	23	2	116
10	90	73	60	---	---	-	39			33	9	--	30	12	86
10	--	-		---	100	98	---	71	49	33	5	3	---	NP	
10	-	---	---	---	100	98		88	73	58	9	4	--	NP	106
10						100		92	78	58	14	4		NP	100

TABLE 16.—*Engineering*

Soil name and location [1]	Parent material	Arcadia Materials Testing Laboratory report number	California Division of Highways report number	Depth	Classification: AASHO [2]	Classification: Unified	Moisture: Maximum dry density
				Inches			*Lb. per cu. ft.*
Holland coarse sandy loam: About 1 mile, airline, NNW. of Breta Mill, S¼ corner sec. 16, T. 10 S., R. 25 E.	Quartz diorite.	2350		0–17	A-4(2)	SM	117
				17–42	A-4(3)	ML-CL	121
				42–99	A-6(5)	SC	123
Merced clay: NE¼SE¼ sec. 25, T. 15 S., R. 16 E.	Mixed dominately granitic alluvium.		VI-59-161	4–12	A-7-5(18)	MH	96
			VI-59-159	12–46	A-7-6(18)	CH	109
Mt. Olive clay: 8/10 mile NNE. of crossing of Orange Cove-Minkler Atchison, Topeka and Santa Fe Railway Company spur line and the Friant-Kern Canal, NW¼SE¼-NE¼ sec. 18, T. 14 S., R. 23 E.	Gabbro-diorite.		VI-62-2364	0–9	A-7-5(11)	ML	104
			VI-62-2365	16–25	A-7-5(15)	MH	
Pond fine sandy loam: About 1 1/10 miles NE. of bridge on McMullin Grade over Fresno Slough bypass, then 200 feet NW.; SE¼SE¼SE¼ sec. 35, T. 16 S., R. 17 E.	Granitic alluvium.		VI-62-2356	0–8	A-4(8)	ML	119
			VI-62-2357	8–17	A-4(3)	CL-ML	128
			VI-62-2358	35–60	A-2-4	SM	116
Porterville clay: About 100 feet NW. of junction of north-south fence line of sec. 18 and Highway 180 (Kings Canyon Road); SE¼NE¼NW¼ sec. 18, T. 14 S., R. 24 E.	Basic igneous colluvium.		VI-62-2352	8–27	A-7-6(18)	CH	
			VI-62-2353	40–71	A-7-5(19)	CH	
Ramona sandy loam, hard substratum: NE¼NE¼SW¼ sec. 36, T. 13 S., R. 22 E.	Granitic alluvium.		VI-59-164	3–7	A-4(2)	SM	130
			VI-59-163	20–28	A-4(2)	SM	132
			VI-59-160	34–60	A-2-4(0)	SM	125
San Joaquin loam: NW¼NE¼NE¼ sec. 29, T. 14 S., R. 24 E.	Granitic alluvium.		VI-59-162	3–11	A-4(3)	CL	123
			VI-59-153	14–20	A-7-6(15)	CL	112
Shaver coarse sandy loam: Cut bank along Dinkey Creek Road, about 1.8 mile W. of center of SW¼ sec. 16, T. 10 S., R. 26 E.	Quartz diorite.	2379	...	0–33	A-2-4	SM	111
				33–73	A-2-4	SM	121
				73	A-1-b	SW-SM	124
Tollhouse extremely rocky coarse sandy loam: Approximate NW. corner of SW¼NE¼ sec. 23, T. 11 S., R. 25 E.	Quartz diorite.	2365–66		0–18	A-2-4(0)	SM	118
				18	A-1-b(0)	SP-SM	121
Traver sandy loam: About 3/16 mile N. of Highway 180 (Whites Bridge Road) and 70 feet W. of E. fence line of sec. 6; SE¼SE¼ sec. 6, T. 16 S., R. 17 E.	Granitic alluvium.		VI-62-2359	2–10	A-4(2)	SM	121
			VI-62-2360	10–23	A-4(8)	ML	128
			VI-62-2361	23–53	A-4(3)	SM	126

[1] Compass directions from Mount Diablo base line and meridian.
[2] Based on American Association of State Highway Officials Designation: M 145–49.

test data—Continued

density ¹	Mechanical analysis														
	Percentage passing sieve—										Percentage smaller than—		Liquid limit	Plasticity index ²	Bulk density
Optimum moisture content	1½ inch	¾ inch	No. 4	No. 8	No. 16	No. 30	No. 40	No. 50	No. 100	No. 200	0.005 mm.	0.001 mm.			
Percent															*Lb. per cu. ft.*
15			100				70			45	18		34	7	75
13			100				72			51	25		30	8	94
12			100				69			45	30		39	18	100
23						100		99	97	92	51	23	59	25	94
18					100	99		97	92	84	49	26	56	33	125
16				100	98	96		89	91	73	29	12	45	15	94
				100	90	97		91	88	76	46	24	53	22	100
11						100		97	92	88	10	5		NP	118
10	---	---	---	---	100	90	-	87	66	52	25	17	17	5	118
12					100	98		38	27	10	5	4		NP	
					100	99	---	98	98	87	56	40	63	24	118
						100		98	93	85	56	40	59	20	124
8				100	98	80		48	45	43	11	3	25	NP	100
11					100	91		74	59	44	17	10	16	9	124
12				100	99	88		68	50	35	8	2	19	NP	
12			100	98	94	89		80	69	51	23	10	27	10	
17				100	99	96	---	86	75	66	40	19	48	31	
16	99	98	97				62			27	9		35	NP	81
12			100				63			26	8		35	NP	94
11		100	99	-	---	--	44	---	---	11	4	--	27	NP	
11	--	--	100	---	---	--	50	---	---	17	4	---	29	NP	---
11		100	89				30			6	2		28	NP	124
9	-				100	94	-	79	68	46	6	4	-	NP	100
10					100	98		95	92	89	16	10	17	3	112
11		-	-	--	100	92		79	85	49	9	4		NP	100

¹ Based on American Association of Highway Officials Designation T 99–57.
² NP = Nonplastic.

TABLE 17.—*Estimated*

[Absence of information indicates a determination was not made

Soil series and map symbols	Depth to— Bedrock or hardpan	Depth to— Seasonal high water table	Shrink-swell potential	Depth from surface (typical profile)	Classification: Dominant USDA texture	Classification: Unified
	Feet	*Feet*		*Inches*		
Academy: AnA, AnB [1]	1½–4½	>10	Moderate Moderate	0–12 12–30 30	Loam Clay loam Mixed sandy loam material (consolidated).	ML or CL CL
Ahwahnee: AcB, AcC [1], AcD, AcE, AdD, AdE, AdF, AeD, AeF, AhD, AhF, AkF. (For properties of Sierra soils in mapping units AhD and AhF refer to Sierra series in this table, and for properties of Tollhouse soils in AkF, refer to Tollhouse series. AkF includes Rock land, described under Granitic rock land.)	1½–4	>10	Low	0–36 36	Coarse sandy loam Weathered rock (coarse sand and loamy coarse sand).	SM
Aiken: AfB [1], AfF	4–5+	>10	Low Moderate	0–21 21–84	Clay loam Clay	ML MH or ML
Alamo: An [1]	1½–4	[2] 0–1	High	0–23 23	Clay and sandy clay Hardpan	CH
Atwater: AoA [1], AoB, ApA, ArA, ArB, AsA, AtA	5+	>10	Low Low Low	0–24 24–43 43–60	Loamy sand or sandy loam. Sandy loam Loamy sand (In places unrelated cemented sediment or clay is at a depth of 2 to 5 feet.)	SM SM SM
Auberry: AuB, AuB2, AuC, AuC2, AuD, AuD2, AuE, AvE, AvD [1], AvF, AvF, AwF, AxD, AxE, AxF, AyF, AzF (For properties of Sierra soils in mapping units AxD, AxE, AxF, and AyF, refer to Sierra series in this table; for properties of Tollhouse soils in AzF refer to Tollhouse series. AzF includes Rock land, described under Granitic rock land.)	1½–6	>10	Low Moderate	0–12 12–42 42	Coarse sandy loam Sandy clay loam Weathered rock that crushes to loamy coarse sand.	SM SC
Basic igneous rock land: BaF (Characteristics too variable to rate onsite investigation needed.)	0–1	>10				
Blasingame: BcC, BcD, BcE [1], BcF, BdF, BgD, BgF, BkF, BlD, BlE, BmE	1½–5	>10	Moderate	0–32 32	Clay loam Weathered rock.	CL

properties

or that it would not be applicable. > = more than; < = less than]

Classification—Continued: AASHO	Percentage passing sieve—: No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction	Salinity[1]
				Inches per hour	*Inches per inch of soil*	*pH value*	
A-4	95-100	90-100	50-60	0.8-2.5	0.18-0.20	5.6-6.5	<1
A-6	95-100	90-100	60-70	0.05-0.2	0.21-0.26	6.1-7.3	<1
A-2	95-100	85-95	25-35	2.5-5.0	0.10-0.12	5.6-6.5	<1
A-6	85-100	95-100	70-80	0.8-2.5	0.20-0.22	5.6-6.5	<1
A-7	95-100	95-100	85-95	0.05-0.2	0.13-0.15	5.0-6.0	<1
A-7	100	100	65-75	<0.05	0.28-0.30	6.6-8.4	0-4
	---	---	---	<0.05			
A-2 or A-4	100	95-100	15-40	5.0-10.0	0.06-0.12	6.1-7.3	<1
A-2 or A-4	100	95-100	25-40	2.5-5.0	0.11-0.13	6.1-7.3	<1
A-2	100	95-100	15-25	5.0-10.0	0.06-0.08	6.1-7.8	<1
A-2	95-100	85-95	25-35	2.5-5.0	0.16-0.18	5.6-6.5	<1
A-4 or A-6	95-100	90-100	35-45	0.8-2.5	0.15-0.17	5.1-6.8	<1
A-6	95-100	95-100	60-70	0.05-0.20	0.16-0.18	6.1-7.8	<1

TABLE 17.—*Estimated*

Soil series and map symbols	Depth to— Bedrock or hardpan	Depth to— Seasonal high water table	Shrink-swell potential	Depth from surface (typical profile)	Classification: Dominant USDA texture	Classification: Unified
	Feet	*Feet*		*Inches*		
Borden: Bn[1], Bs, Bt, Bu	5+	>10	Moderate	0-38	Sandy clay loam	CL
			Moderate	38-60	Heavy sandy loam (In places silt is at a depth of 3 to 4 feet.)	SM
Cajon: Ca, Cb[1], Cc, Cd, Ce	5+	>10	Low	0-63	Loamy coarse sand (In places silt is at a depth of 3 to 4 feet.)	SM
Calhi: CfA[1], CfB, CgA	5+	>10	Low	0-60	Loamy sand (In places silt is at a depth of 2½ to 5 feet.)	SM
Centerville: ChA[1], CnC, CkB, CkD	2-4	>10	High	0-33	Clay (Cobbly in places.)	CH
				33	Cobbly sandy material (consolidated)	
Chino: Cl, Cm, Cn, Co, Cp, Cr[1], Cs	5+	>10	Moderate	0-18	Loam	ML or CL
			Low	18-60	Heavy fine sandy loam. (In places silt is at a depth of 2½ to 4 feet.)	SM
Chualar: CtA[1], CtB	5+	>10	Moderate	0-60	Sandy clay loam	SC
Cibo: CuC, CuD, CuE, CvD, CvE, CvF[1], CwD, CwF	1½-5	>10	High	0-23	Clay	CH
				23	Weathered rock	
Coarsegold: CxC, CxD, CxE, CxF[1], CyF	1½-4½	>10	Moderate	0-32	Light clay loam	ML
				32	Weathered rock	
Colluvial land: CzF (Characteristics too variable to rate; onsite investigation needed.)	5+	>10				
Cometa: CzaB[1], CzaC, CzaD, CzbD, CzcB (For properties of San Joaquin soils in mapping unit CzcB, refer to San Joaquin series in this table.)	5+	>10	Low	0-17	Sandy loam (Loam in places.)	SM
			High	17-26	Clay	CH
			Low	26-60	Weakly cemented coarse sandy loam.	SM
Delhi: DhA[1], DhB, DtA	5+	>10	Low	0-60	Loamy sand (In places silt is at a depth of 2 to 4 feet.)	SM
DeA, DeB	5+	>10	Low	0-60	Sand	SM
Dello: Dm[1], Dn	5+	[3]0-5+	Low	0-36	Loamy sand (In places sandy loam to a depth of 15 inches.)	SM
			Low	36-60	Sand	SM

properties—Continued

Classification—Continued	Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity [1]
AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH value*	
A-4 or A-6	100	100	50–60	0.2–0.8	0.19–0.21	6.6–8.4	[4] <4
A-4	100	100	40–50	[4] 0.8–2.5	0.16–0.20	7.9–8.4	[4] <4
A-2	95–100	95–100	15–30	[4] 5.0–10.0	0.06–0.08	7.4–9.8	[4] 0–4
A-2	100	95–100	20–30	[4] 5.0–10.0	0.06–0.08	7.4–9.0	0–4
A-7	90–100	90–100	80–95	<0.05	[4] 0.28–0.30	6.6–8.4	0–4
				<0.05		7.9–8.4	
A-4 or A-6	100	100	60–65	0.8–2.5	0.26–0.28	6.6–8.4	[4] 0–4
A-4	100	100	35–45	[4] 2.5–5.0	0.11–0.13	7.4–8.4	[4] 0–4
A-4 or A-6	100	90–100	35–50	0.2–0.8	0.18–0.20	6.6–8.4	<1
A-7	90–100	90–100	80–90	0.05–0.2	0.28–0.30	6.6–8.4	<4
A-4	90–100	85–100	55–65	0.2–0.8	0.18–0.20	5.6–7.3	<1
A-4	95–100	90–95	35–45	2.5–5.0	0.06–0.08	5.6–6.5	<1
A-7	95–100	90–100	55–65	<0.05	0.14–0.16	6.1–7.8	<1
A-2	90–100	95–100	25–35	0.05–0.20	0.06–0.08	6.1–7.3	
A-2	100	100	20–30	[4] 5.0–10.0	0.06–0.08	6.1–7.3	<1
A-3	100	100	5–10	>20.0	0.04–0.06	6.1–7.8	<1
A-2	100	100	20–35	>20.0	0.06–0.08	6.1–8.4	0–4
A-3	100	95–100	5–10	>20.0	0.04–0.06	6.6–8.4	0–4

TABLE 17.—*Estimated*

Soil series and map symbols	Depth to— Bedrock or hardpan	Depth to— Seasonal high water table	Shrink-swell potential	Depth from surface (typical profile)	Classification: Dominant USDA texture	Classification: Unified
	Feet	*Feet*		*Inches*		
Delpiedra: DpE, DpF[1], DsF. (For properties of Fancher soils in mapping unit DsF refer to Fancher series in this table.)	1-1½	>10	Moderate	0-12	Stony heavy loam	CL
				12	Weathered rock.	
El Peco: Ec, Ed[1], Ep.	1½-3	>10	Low	0-28	Fine sandy loam (Loam or sandy loam in places.)	SM or ML
				28-33	Hardpan	
			Low	33-60	Silt loam	ML
Exeter: Ex[1], Et, Ex.	1-3	>10	Low	0-30	Sandy loam or loam.	SM or ML
				30	Hardpan	
Fallbrook: FaB, FaC, FaD, FaE, FbB, FbD, FcD[1], FcF, FdD, FdF, FeE.	1-3½	>10	Low	0-11	Sandy loam	SM
			Moderate	11-29	Sandy clay loam	SC
				29	Weathered rock.	
Fancher: FfE, FfF[1], FiE, FiF. (For properties of Blasingame soils in mapping units FiE and FiF refer to Blasingame series in this table.)	1½-3	>10	Moderate	0-25	Gravelly clay loam (Stones on 3 to 15 percent of surface.)	CL
				25	Weathered rock.	
Foster: Fm[1], Fn, Fo, Fp, Fr.	5+	3-5+	Low	0-30	Stratified sandy loam. (Loam surface in places.)	SM
			Low	30-60	Stratified loamy sand. (Weakly cemented sand and silt in places.)	SM
Fresno: Fs, Ft, Fu[1], Fv, Fw, Fx. (For properties of Traver soils in mapping unit Fx refer to Traver series in this table.)	1-4	>10	Low	0-6	Fine sandy loam (Clay loam in places.)	ML or CL
			Moderate	6-12	Light clay loam	CL
			Low	12-21	Loam	ML or CL
				21-29	Hardpan (variable)	
			Low	29-63	Stratified sand and silt.	SM and ML
Friant: FyD, FyE[1].	½-1½	>10	Low	0-14	Fine sandy loam	SM
				14	Slightly weathered rock.	
Grangeville: Gf[1], Gg, Gh, Gk, Gl, Gm, Gn, Go, Gp.	5+	[2]>10	Low	0-60	Fine sandy loam (In places unrelated sand, gravel, and weakly cemented sand at a depth of 2 to 5 feet.)	ML
Ga, Gd, Ge	5+	>10	Low	0-60	Sandy loam (In places sand is at a depth of 2½ to 4 feet.)	SM

properties—Continued

Classification—Continued: AASHO	Percentage passing sieve—: No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction	Salinity [1]
				Inches per hour	*Inches per inch of soil*	*pH value*	
A-6	40–60	35–45	25–35	0.05–2.5	0.10–0.12	6.1–7.8	<1
A-4	100	100	45–60	2.5–5.0	0.08–0.12	7.9–9.0	4–15
A-4	100	100	75–95	<0.05 0.05–0.20	...... 0.14–0.16	...... 8.5–9.5	 4–15
A-4	100	95–100	35–55	2.5–5.0	0.12–0.15	6.1–7.8	<1
				<0.05			
A-2	95–100	90–100	25–35	2.5–5.0	0.09–0.11	6.1–7.3	<1
A-4	95–100	95–100	35–45	0.8–2.5	0.10–0.12	6.1–7.8	<1
A-6	75–95	70–85	55–75	0.05–0.2	0.16–0.18	5.6–7.3	<1
A-4	100	100	35–50	0.8–5.0	0.12–0.18	6.6–8.4	[2]0–4
A-2	100	100	25–35	[2]5.0–10.0	0.06–0.08	7.4–8.4	[2]0–4
A-4 or A-6	100	100	50–70	2.5–5.0	0.20–0.22	7.9–9.5	0–30
A-6	100	100	70–80	0.2–0.8	0.20–0.22	7.9–9.5	0–30
A-4 or A-6	100	95–100	50–70	0.8–2.5	0.18–0.20	7.9–9.5	0–30
				<0.05			
A-4	100	95–100	40–60	0.05–0.20	0.20–0.22	8.5–9.6	0–30
A-4	90–100	85–95	35–45	2.5–5.0	0.10–0.12	6.1–7.8	<1
A-4	100	95–100	50–60	[2]2.5–5.0	0.16–0.18	6.1–9.0	[2]0–4
A-2 or A-4	100	95–100	20–40	[2]2.5–5.0	0.11–0.12	6.1–8.0	[2]0–4

TABLE 17.—*Estimated*

Soil series and map symbols	Depth to—		Shrink swell potential	Depth from surface (typical profile)	Classification	
	Bedrock or hardpan	Seasonal high water table			Dominant USDA texture	Unified
	Feet	*Feet*		*Inches*		
Granitic rock land: GrF (Characteristics too variable to rate; onsite investigation needed.)	0–1	>10				
Greenfield: GeA, GfA[1] GfB, GgA	5+	>10	Low	0–60	Sandy loam and coarse sandy loam. (In places weakly cemented sand is at a depth of 2 to 4 feet.)	SM
Hanford: Hm[1] Hn, Ho, Hp, Hr	5+	>10	Low	0–72	Fine sandy loam. (In places gravel, silt, clay loam, or weakly cemented sand is at a depth of 2 to 4 feet.)	ML or SM
Ha, Hb, Hc, Hd, He, Hf, Hg, Hh, Hk	5+	>10	Low	0–72	Sandy loam (Sand, gravel, silt, or clay loam or weakly cemented sand at a depth of 2 to 4 feet.)	SM
Hl	5+	>10	Low	0–72	Gravelly sandy loam.	SM
Hesperia: Hsa, Hsc, Hsd, Hse, Hsm, Hsn, Hso, Hsp, Hsr, Hss, Hst[1], Hsy	5+	>10	Low	0–42	Fine sandy loam	SM
			Low	42–63	Compact silt	ML
Hideaway: HtC[1]	0–1	>10	Low	0–8	Extremely stony loam.	ML
				8	Slightly weathered basalt.	
Hildreth: Hu[1]	5+	[1]2–5	High	0–46	Clay	CH
				46–64	Sandy material or weathered rock.	
Holland: HvC[1]	4–7	>10	Low	0–10	Coarse sandy loam	SM
			Moderate	10–75	Sandy clay loam	SC or CL
				75	Weathered rock	
Honcut: HwA[1] HwB, HyA, HzA	5+	>10	Low	0–62	Fine sandy loam (In places gravel or weakly cemented silt is at a depth of 2 to 3½ feet.)	SM
Keefers: KoC, KfD[1]	3–5+	>10	Moderate	0–32	Cobbly clay	CH
			Low	32–60	Very cobbly loam	ML
Keyes: KmC[1]	1–2	>10	Moderate	0–20	Cobbly clay	CH
				20–26	Cobbly hardpan	
			Low	26–60	Compact cobbly or gravelly coarse sandy loam.	GM
Los Robles: LhB, LgB, LmA[1], LmB, LnB, LoA	5+	>10	Moderate	0–38	Clay loam	ML or CL
			Low	38–60	Coarse sandy loam (In places gravel or weakly cemented sand is at a depth of 2 to 4 feet.)	SM

properties—Continued

Classification—Continued	Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity[1]
AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH value*	
A-2 or A-4	95–100	90–100	30–40	[2]2.5–5.0	0.12–0.14	6.1–7.8	<1
A-4	100	100	45–55	[2]2.5–5.0	0.12–0.14	6.1–7.8	<1
A-2 or A-4	100	95–100	30–40	[2]2.5–5.0	0.10–0.12	6.1–7.8	<1
A-2	65–90	60–85	15–30	2.5–5.0	0.07–0.09	6.1–7.8	<1
A-4	100	95–100	35–45	2.5–5.0	0.12–0.14	6.1–7.8	[2]<4
A-4	100	95–100	70–80	0.2–0.8	0.04–0.06	7.8–9.0	[2]<4
A-4	50–60	40–50	25–30	0.8–2.5	0.03–0.05	5.1–6.5	<1
A-7	100	95–100	70–80	0.06–0.2	0.28–0.30	6.1–8.4	<4
			---	<0.06	---	---	---
A-4	95–100	95–100	35–50	2.5–5.0	0.16–0.18	8.6–6.5	<1
A-6	95–100	95–100	40–55	0.20–0.05	0.14–0.16	5.1–6.5	<1
A-2	100	95–100	25–35	[2]2.5–5.0	0.13–0.15	6.1–7.8	<1
A-7	60–75	55–70	30–45	0.06–0.2	0.10–0.12	5.6–7.3	<1
A-4	25–55	20–50	5–25	0.8–2.5	0.04–0.08	6.6–7.8	<1
A-7	70–85	65–80	35–50	0.06–0.2	0.10–0.12	5.1–7.8	<1
				<0.06			
A-2	70–80	65–80	15–25	0.2–0.8	0.06–0.08	6.6–7.8	<1
A-4 or A-6	100	95–100	65–75	0.2–2.5	0.20–0.22	6.1–7.8	<1
A-2	100	95–100	25–35	[2]2.5–5.0	0.10–0.12	6.6–7.8	<1

TABLE 17.—*Estimated*

Soil series and map symbols	Depth to— Bedrock or hardpan	Depth to— Seasonal high water table	Shrink swell potential	Depth from surface (typical profile)	Classification: Dominant USDA texture	Classification: Unified
	Feet	*Feet*		*Inches*		
Madera: Ma, Mc[1], Md, Me	2–4	>10	Low	0–20	Loam (Sandy loam or clay loam in places.)	ML, CL, or SM
			High	20–33	Clay or heavy clay loam.	CH
				33–41	Hardpan	
				41–60	Weakly cemented sandy loam.	SM
Merced: Mf, Mg, Mh, Mk[1], Ml, Mm	5+	>10	High	0–56	Clay	CH or MH
			Moderate	56–70	Clay loam	ML or CL
Millerton: MnD[1], MnE, MnF, MnF2, MoD, MoE, MoF	½–2	>10	Low	0–14	Fine sandy loam	SM
				14	Weathered rock.	
Montpellier: MpC[1], MpD	5+	>10	Low	0–16	Coarse sandy loam	SM
			Moderate	16–55	Coarse sandy clay loam.	SC
			Low	55–70	Loamy coarse sand	SM
Mt. Olive: MtB, MtC[1]	1½–3½	>10	High	0–35	Clay	MH
				35	Strongly weathered rock.	
Nord: No, Ns[1]	5+	>10	Low	0–44	Loam	ML
			Moderate	44–66	Clay loam	ML or CL
Pachappa: Pa, Pc, Pd[1], Pe	5+	>10	Moderate	0–42	Loam or light clay loam.	ML or CL
			Low	42–60	Silt loam	ML
Piper: PfB[1], PgB, PhB (For properties of Rossi soils in mapping unit PhB refer to Rossi series in this table.)	5+	>10	Low	0–68	Sandy loam	SM
Pits: Pk (Characteristics too variable to rate; onsite investigation needed.)	5+	([2])				
Playas: Pl (Characteristics too variable to rate; onsite investigation needed.)	5+	([2])				
Pollasky: PmB, PmC[1], PmD, PoB, PoC, PoC, PoD, PpC (For properties of Montpellier soils in mapping units PoC and PoD refer to Montpellier series in this table and for properties of Rocklin soils in PpC refer to Rocklin series.)	1½–3½	>10	Low	0–39	Sandy loam	SM
				39	Consolidated sandy sediment.	

properties—Continued

Classification—Continued	Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity[1]
AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH value*	
A-4 or A-6	95–100	95–100	40–60	0.2–6.0	0.11–0.20	6.1–9.0	[4] 0–4
A-7	95–100	95–100	65–75	<0.05	0.12–0.14	6.1–9.0	[4] 0–4
A-2 or A-4	95–100	95–100	20–40	<0.05 0.05–0.20			
A-7 A-4 or A-6	100 100	100 100	85–95 50–80	<0.05–0.2 0.2–0.8	0.38–0.40 0.20–0.22	6.6–8.4 7.3–8.4	[4] 0–4 0–8
A-4	80–100	90–100	40–50	2.5–5.0	0.12–0.14	6.1–7.3	<1
A-2 A-4 or A-6	95–100 95–100	90–100 90–100	25–35 35–50	2.5–5.0 0.5–0.20	0.10–0.12 0.14–0.16	5.6–7.3 6.1–7.3	<1 <1
A-2	90–100	85–95	15–25	5.0–10.0	0.06–0.08	6.1–7.3	<1
A-7	100	95–100	70–80	0.05–0.20	0.24–0.26	7.4–8.4	<4
A-4 A-4 or A-6	95–100 95–100	90–95 85–95	55–65 65–75	0.8–2.5 0.2–0.8	0.20–0.22 0.35–0.37	6.6–9.0 7.9–9.5	[6] <4 [6] <4
A-4 or A-6	100	95–100	60–70	0.8–2.5	0.22–0.24	7.4–8.4	[6] <4
A-4	100	95–100	70–80	0.2–0.8	0.16–0.18	7.8–8.4	[6] <4
A-2	100	95–100	20–30	2.5–5.0	0.10–0.12	7.9–9.5	[6] 4–8
A-4	100	100	40–50	2.5–5.0	0.09–0.11	6.1–7.3	<1

TABLE 17.—*Estimated*

Soil series and map symbols	Depth to— Bedrock or hardpan	Depth to— Seasonal high water table	Shrink-swell potential	Depth from surface (typical profile)	Classification: Dominant USDA texture	Classification: Unified
	Feet	*Feet*		*Inches*		
Pond: Pr, Ps, Pt[1], Pu, Pv, Pw	5+	>10	Low	0–8	Fine sandy loam or loam.	SM or ML
			Moderate	8–35	Sandy clay loam or clay loam.	CL
			Low	35–60	Stratified sandy loam and sand. (In places compact silt is at a depth of 2 to 4 feet.)	SM
Porterville:						
PxA[1], PxC	5+	>10	High	0–71	Clay	CH
PyC, PzD	5+	>10	Moderate to high	0–71	Cobbly and very cobbly clay.	CH
Positas: PzaD, PzaD, PzaE[1]	5+	>10	Low	0–4	Gravelly loam	ML
			High	4–24	Clay	CH
			Low	24–36	Gravelly sandy clay loam.	SC
			Low	36–60	Compact gravelly or cobbly sandy loam.	SM
Ramona: Ra[1], Rb, Rc, Rd, Re	5+	>10	Low	0–24	Sandy loam or loam.	SM or ML
			Moderate	24–39	Sandy clay loam or clay loam.	SC or CL
			Low	39–78	Coarse sandy loam. (In places gravel and cobblestones or weakly cemented sand is at a depth of 2 to 4 feet.)	SM
Redding: RfC, RgD[1]	1–3	>10	Low	0–9	Gravelly loam	SC
			Moderate	9–12	Clay	CH
				12–20	Gravelly hardpan	
			Low	20–60	Gravelly coarse sandy loam to gravelly clay loam.	SM or SC
Riverwash: Rh. (Characteristics too variable to rate; onsite investigation needed.)	5+	[1]0–4				
Rocklin: RkB[1], RlD	1½–3	>10	Low	0–23	Sandy loam	SM
			Moderate	23–31	Sandy clay loam	SC or CL
				31–60	Strongly to weakly cemented hardpan. (Weakly consolidated sediment below hardpan in places.)	
Rossi: Rr[1], Rs	5+	>10	Low to moderate	0–12	Fine sandy loam. (Clay loam in mapping unit Rs.)	SM or CL
			Moderate	12–38	Clay loam	CL
			Low	38–65	Stratified loam and loamy sand.	ML or SM

properties—Continued

Classification—Continued	Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity [1]
AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH value*	
A-4	100	100	35–60	0.8–2.5	0.10–0.12	7.9–9.0	0–15
A-4 or A-6	100	100	60–70	0.2–0.8	0.22–0.24	8.5–10.5	4–30
A-2	100	100	15–35	[2] 2.5–5.0	0.08–0.10	9.0–10.5	0–15
A-7	100	95–100	75–85	0.05–0.2	0.28–0.30	6.6–8.4	<4
A-7	45–85	40–80	30–60	0.05–0.2	0.10–0.20	6.6–8.4	<4
A-4	70–80	65–75	35–50	0.8–2.5	0.12–0.14	5.1–7.8	<1
A-7	90–95	85–95	55–65	<0.05	0.16–0.18	5.6–7.8	<1
A-4	70–80	65–75	35–45	0.05–0.2	0.12–0.14	5.6–7.8	<1
A-2	70–80	65–75	20–30	0.05–0.2	0.08–0.10	5.6–7.8	<1
A-4	100	95–100	35–55	2.5–5.0	0.14–0.16	6.1–7.3	<1
A-4 or A-6	100	95–100	40–60	0.20–0.80	0.17–0.19	6.1–7.3	<1
A-2	95–100	90–100	20–30	[2] 2.5–5.0	0.08–0.10	6.6–7.3	<1
A-4	75–90	70–85	40–50	0.8–2.5	0.10–0.12	5.1–6.5	<1
A-7	95–100	90–100	50–60	<0.05	0.16–0.18	4.5–5.5	<1
				<0.05			
A-2 or A-4	65–85	60–80	20–40	0.20–5.0	0.08–0.12	6.0–7.8	<1
A-2 or A-4	95–100	90–100	30–40	2.5–5.0	0.12–0.14	5.6–6.5	<1
A-4	95–100	90–100	40–55	0.8–2.5	0.12–0.14	5.1–7.3	<1
				<0.05			
A-4 or A-6	95–100	90–100	35–60	0.8–2.5	[4] 0.12–0.14	7.9–9.0	0–8
A-6	90–100	85–100	70–80	0.05–0.20	0.10–0.20	8.5–10.5	4–50
A-4	95–100	90–100	40–60	0.8–2.5	0.10–0.15	9.0–10.5	4–50

TABLE 17.—*Estimated*

Soil series and map symbols	Depth to—		Shrink-swell potential	Depth from surface (typical profile)	Classification	
	Bedrock or hardpan	Seasonal high water table			Dominant USDA texture	Unified
	Feet	*Feet*		*Inches*		
Sandy alluvial land: Sa	5+	(²)	Low	0–42	Stratified loamy fine sand and fine sandy loam.	SM or ML
			Moderate	42–60	Clay loam	CL
Sandy alluvial land, leveled: Sb (Characteristics too variable to rate; onsite investigation needed.)	5+	>10				
San Joaquin: ScA¹, SdA, SdB, SeA, SfA, SgA, SgB, ShB (For properties of Alamo soils in mapping unit ShB refer to Alamo series in this table.)	1–4	>10	Low to moderate	0–16	Sandy loam and loam	SM or ML
			Moderate	16–28½	Sandy clay loam and clay	CL
				28½–36	Hardpan	
			Low	36–60	Weakly cemented coarse sandy loam (In places gravel and cobblestones at a depth of 2 to 4 feet.)	SM
Sesame: SkB¹, SkC, SkD, SlB, SlC	1½–3½	>10	Low to moderate	0–10	Sandy loam and loam.	SM or ML
			Moderate	10–30	Sandy clay loam and sandy loam	SC
				30	Weathered rock.	
Shaver: SmE¹	5+	>10	Low	0–60	Coarse sandy loam	SM
				60	Weathered rock.	
Sierra: SnC, SnD¹, SnE, SoC, SoD, SoE, SrE, SrF (For properties of Tollhouse soils in mapping unit SrF refer to Tollhouse series in this table. SrF includes Rock land, described under Granitic rock land.)	5+	>10	Low	0–13	Sandy loam	SM
			Moderate	13–72	Clay loam and sandy clay loam.	CL
				72	Weathered rock.	
Swamp: Sw² (Characteristics too variable to rate; onsite investigation needed.)	5+	²0–1				
Temple: Ta, Tb, Tc, Td², Te, Tf, Tg	5+	>10	Moderate	0–31	Clay loam (Clay or loam surface layer in places.)	CL
			Low	31–68	Sandy loam and loamy sand	SM
Terrace escarpments: ThF (Characteristics too variable to rate; onsite investigation needed.)	²5+	>10				

properties—Continued

Classification—Continued	Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity [4]
AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH value*	
A–4	100	100	40–60	2.5–5.0	0.08–0.15	6.6–7.8	<4
A–6	100	100	70–80	0.05–0.20	0.30–0.32	8.5–10.5	4–50
A–4	100	95–100	35–60	0.8–2.5	0.10–0.14	5.6–7.3	<1
A–6 or A–7	100	95–100	65–70	0.05–0.20	0.10–0.14	6.1–7.8	<1
A–2	95–100	95–100	25–35	<0.05 [5] 0.05–0.20	0.06–0.08	6.6–7.3	<1
A–4	95–100	90–100	35–60	0.8–5.0	0.10–0.16	5.0–6.5	<1
A–4	95–100	90–100	40–50	0.2–0.8	0.12–0.14	6.1–7.8	<1
A–2	90–100	85–100	25–35	2.5–5.0	0.10–0.12	5.6–6.5	<1
A–4	95–100	90–100	40–50	2.5–5.0	0.18–0.20	6.1–7.8	<1
A–4 or A–6	90–100	85–95	60–70	0.2–0.8	0.16–0.18	5.6–7.8	<1
A–6	100	95–100	65–75	0.2–0.8	0.24–0.26	6.6–9.0	[6] <4
A–2	100	95–100	20–35	2.5–5.0	0.10–0.16	7.9–9.8	[6] <4

TABLE 17.—*Estimated*

Soil series and map symbols	Depth to— Bedrock or hardpan	Depth to— Seasonal high water table	Shrink-swell potential	Depth from surface (typical profile)	Classification: Dominant USDA texture	Classification: Unified
	Feet	*Feet*		*Inches*		
Tivy: TkB, TkD[1], TkE, TkF, TlD, TlF.	1-2½	>10	Moderate	0–26	Loam	ML
				26	Weathered rock.	
Tollhouse: TmF[1]	½–1½	>10	Low	0–18	Gravelly coarse sandy loam.	SM
				18	Weathered rock.	
Toomes: TnF[1]	½-1	>10	Low	0–5	Extremely cobbly loam.	ML
				5	Slightly weathered basaltic mudflow rock.	
Trabuco: ToC, ToD, ToE, ToF[1], TpC, TpF	2½-6	>10	Moderate	0–10	Loam	ML
			High	10–30	Light clay and sandy clay loam.	CL
				30	Strongly weathered rock.	
Traver: Tr, Ts[1], Tt, Tu	5+	>10	Low	0–10	Sandy loam or fine sandy loam.	SM
			Moderate	10–23	Sandy clay loam	SC or ML
				23–53	Sandy loam	SM
				53–60	Silt (compact)	ML
Tretten: TvC, TvD, TvE[1], TvF, TwF	2–3½	>10	Low	0–36	Fine sandy loam	ML
				36	Weathered rock	
Trimmer: TxC, TxD, TxE[1], TxF, TyE, TyF, TzE, TzF. (For properties of Tretten soils in mapping units TzE and TzF, refer to Tretten series in this table.)	2-4	>10	Low	0–14	Loam	ML
			Moderate	14–31	Clay loam and sandy clay loam.	SC or CL
				31	Weathered rock	
Tujunga:						
TzbA[1], TzbB	5+	>10	Low	0–60	Loamy sand and sand.	SM
TzaA, TzcA, TzcB	5+	>10	Low	0–60	Sand (Gravel and cobblestones at a depth of 2 to 4 feet in places.)	SM
TzdA	5+	>10	Low	0–60	Cobbly loamy sand	SM
Visalia: VaA[1], VaB, VdA, VeA	5+	>10	Low	0–60	Sandy loam (Loam in places or clay loam at a depth of 3 to 4 feet.)	SM
Vista: VfB, VfC, VfD, VfE, VfF, VgB, VgD[1], VgF, VhD, VkE, VkF, VlD, VlF, VmD, VnD, VoD, VoE, VsF. (For properties of Fallbrook soils in mapping units VnD, VoD, VoE, and VsF, refer to Fallbrook series in this table.)	1½–3½	>10	Low	0–30	Coarse sandy loam	SM
				30	Weathered rock.	

properties—Continued

Classification—Continued	Percentage passing sieve—						
AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction	Salinity [1]
				Inches per hour	*Inches per inch of soil*	*pH value*	
A-4	90–100	85–95	60-60	0.8–2.5	0.12–0.14	5.6–7.3	<1
A-2	75–90	70–85	15–30	5.0–10.0	0.08–0.10	5.6–6.5	<1
A-4	35–65	30–60	20–35	0.8–2.5	0.06–0.08	6.1–7.3	<1
A-4	90–100	85–95	55–65	0.8–2.5	0.18–0.20	6.1–7.3	<1
A-6	90–100	85–95	65–75	0.05–0.20	0.14–0.16	6.1–7.8	<1
A-4	100	100	35–50	2.5–5.0	0.08–0.10	7.4–9.0	[2] 4–8
A-4	100	100	45–60	0.8–2.5	0.14–0.16	7.9–10.0	[2] 4–8
A-4	100	100	35–50	2.5–5.0	0.10–0.12	9.0–10.5	[2] 8–12
A-4	100	100	85–95	0.2–0.8	0.12–0.16	8.5–9.5	[2] 4–8
A-4	95–100	90–100	50–60	0.8–2.5	0.10–0.12	6.1–7.3	<1
A-4	95–100	90–100	50–60	2.5–5.0	0.16–0.18	6.1–7.3	<1
A-4 or A-6	95–100	90–100	45–65	0.2–0.8	0.12–0.14	5.6–7.3	<1
A-1 or A-2	95–100	90–100	10–30	5.0–10.0	0.06–0.08	6.1–7.8	<1
A-3	100	100	5–10	>20.0	0.04–0.06	6.1–7.8	0–4
A-1 or A-2	65–85	60–80	5–15	5.0–10.0	0.04–0.06	6.1–7.8	<1
A-2 or A-4	100	95–100	30–40	[2] 2.5–5.0	0.13–0.15	6.1–7.8	<1
A-2	90–100	85–95	25–35	2.5–5.0	0.10–0.12	5.6–7.3	<1

TABLE 17.—*Estimated*

Soil series and map symbols	Depth to— Bedrock or hardpan	Depth to— Seasonal high water table	Shrink-swell potential	Depth from surface (typical profile)	Classification Dominant USDA texture	Classification Unified
	Feet	*Feet*		*Inches*		
Waukena: Wa[2], We	5+	>10	Low	0–4	Fine sandy loam (Loam in places.)	SM or ML
			Moderate	4–19	Sandy clay loam or clay loam.	SC or CL
			Low	19–61	Stratified loam, sandy loam, and loamy fine sand.	SM
Whitney: WhB, WhD, WhE, WhF[2], WrD	2½–5	>10	Low	0–24	Loam	ML
			Moderate	24–40	Clay loam	CL
				40	Strongly weathered rock.	
Wunjey: Ws, Wu[2]	5+	>10	Low	0–66	Silt loam (Fine sandy loam surface layer in places.)	ML
Yokohl: YhA[2], YhB, YkA, YkB, YlB, YmA	1–3½	>10	Moderate	0–10	Loam and clay loam. (Gravelly in places.)	ML, CL, or SC
			Moderate to high	10–14	Clay (Gravelly in places.)	CH or SC
				14–18	Hardpan	
				18–60	Weakly to strongly cemented sandy loams.	

[1] Expressed in millimhos per centimeter at 25° C.
[2] This soil has the profile described as typical for the series.
[3] Subject to local flooding or is seasonally ponded.
[4] In places permeability is less than 0.05.
[5] In places below a depth of 3 feet, permeability is 0.05 to 0.20 inches per hour.
[6] In places salinity is 4 to 16.
In places below a depth of 2½ feet, permeability is 0.05 to 0.20 inch.
[8] Available water capacity is 0.18 to 0.20 where the soil is cobbly.
[9] In places below a depth of 2 feet, permeability is 0.05 to 0.20 inch.
[10] In mapping units Gr and Gs, seasonal high water table is at a depth of 2 to 4 feet.
[11] In places below a depth of 2 feet, permeability is 0.05 to 0.20 inch or is more than 10 inches.
[12] In places salinity is 4 to 8.

TABLE 18.—*Engineering*

[Not included in this table, because their characteristics are too variable for engineering use, are the land types Basic igneous (Sa), Sandy alluvial land, leveled (Sb), Swamp

Soil series and map symbols	Suitability as source of— Topsoil	Suitability as source of— Sand	Suitability as source of— Gravel	Suitability as source of— Road fill	Hydrologic soil group
Academy: AaA, AaB	Fair: Clay loam less than 40 inches thick.	Unsuitable: More than 50 percent material passing No. 200 sieve.	Unsuitable: Less than 5 percent gravel throughout profile.	Fair and poor: A-4 and A-6.	C

properties—Continued

Classification—Continued: AASHO	Percentage passing sieve: No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction	Salinity[1]
				Inches per hour	*Inches per inch of soil*	*pH value*	
A-4	95–100	95–100	25–60	0.8–2.5	0.12–0.14	7.4–10.4	0–4
A-4 or A-6	95–100	95–100	40–60	<0.05	0.04–0.06	8.5–10.4	4–8
A-4	90–100	95–100	35–45	0.8–2.5	0.16–0.18	7.9–10.4	0–4
A-4 A-6	100 100	95–100 95–100	55–65 60–70	0.8–2.5 0.05–0.2	0.24–0.26 0.15–0.17	6.1–7.3 6.1–7.3	<1 <1
A-4	100	95–100	80–90	0.8–2.5	0.30–0.32	7.9–9.0	4–50
A-4 or A-6	75–100	70–100	40–80	0.2–0.8	0.10–0.16	6.1–7.8	<1
A-7	70–100	65–100	40–90	0.05–0.2	0.10–0.16	6.1–7.8	<1
				<0.05 0.05–0.20	....	6.6–8.4	....

In places below a depth of 2 feet, permeability is more than 20 inches or is 0.05 to 0.20 inch.
In places salinity is 4 to 20.
In places salinity is 8 to 20.
Available water capacity is 0.18 to 0.20 inch in mapping unit Rs.
In places below a depth of 2 feet, permeability is more than 20 inches.
Subject to continual flooding from streams or seepage.
Hardpan in places.
In places salinity is 0 to 50.
In places at a depth below 3 feet, permeability is 0.2–0.8 inch.
In places salinity is 4 to 50.
Available water capacity is 0.30 to 0.32 if the soil is reclaimed.

interpretations

rock land (BnF), Colluvial land (CaF), Granitic rock land (GrF), Pits (Ps), Playas (Pl), Riverwash (Rh), Sandy alluvial land (Sw), and Terrace escarpments (TbF)]

Soil features affecting—: Road location	Water retention: Embankments	Reservoir area	Agricultural drainage	Irrigation
In many places a temporary perched water table develops above dense subsoil.	Fair to good stability, medium to high compressibility.	Low seepage, underlying material broken by vertical and horizontal cracks in places.	Slow permeability.	Moderate to high water-holding capacity, slow intake rate.

TABLE 18.—*Engineering*

Soil series and map symbols	Suitability as source of— Topsoil	Sand	Gravel	Road fill	Hydrologic soil group
Ahwahnee: AcB, AcC, AcD, AcE, AdD, AdE, AdF, AeD, AeF, AhD, AhF, AkF. (For interpretations of Sierra soils in mapping units AhD and AhF refer to Sierra series in this table, and for interpretations of Tollhouse soils in AkF refer to Tollhouse series. AkF includes Rock land, described under Granitic rock land in text.)	Fair: Moderately deep, and coarse sandy loam.	Poor: 25 to 35 percent material passing No. 200 sieve.	Unsuitable: Less than 5 percent gravel throughout profile.	Good: A-2	B
Aiken: AiB, AmF	Fair to poor: clay loam to a depth of 20 inches; clay below.	Unsuitable: More than 70 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Poor: A-6 and A-7	C
Alamo: An	Poor: Clay	Unsuitable: More than 65 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Poor: A-7	D
Atwater: AoA, AoB, ApA, ArA, ArB, AsA, AtA	Poor to fair: loamy sand to sandy loam.	Fair to poor: 15 to 40 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Good to fair: A-2 and A-4	B
Auberry: AuB, AuB2, AuC, AuC2, AuD, AuD2, AuE, AuF, AvD, AvE, AvF, AwF, AxD, AxE, AxF, AyF, AzF. (For interpretations of Sierra soils in mapping units AxD through AyF refer to Sierra series in this table; and for interpretations of Tollhouse soils in AzF refer to Tollhouse series. AzF includes Rock land, described under Granitic rock land in text.)	Fair: Coarse sandy loam and sandy clay loam.	Good to poor: 15 to 45 percent material passing No. 200 sieve.	Unsuitable: Less than 15 percent gravel in profile.	Poor to good: A-2, A-4, and A-6.	B
Blasingame: BoC, BoD, BoE, BoF, BrF, BsD, BsF, BkF, BtD, BtE, BtF	Fair: Clay loam less than 40 inches thick.	Unsuitable: More than 50 percent material passing No. 200 sieve.	Unsuitable: Less than 5 percent gravel in profile.	Poor: A-6	C
Borden: Bn, Bs, Bt, Bu	Fair to poor: sandy clay loam less than 10 inches thick, saline in places.	Unsuitable: Mostly more than 50 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Poor to fair: A-4 and A-6.	B
Cajon: Ca, Cb, Cc, Cd, Ce	Poor: Loamy sand.	Fair to poor: 15 to 30 percent material passing No. 200 sieve.	Unsuitable: Less than 5 percent gravel in profile.	Good: A-2	A
Calhi: CfA, CfB, CgA	Poor: Loamy sand.	Poor: 20 to 30 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Good: A-2	A

interpretations—Continued

Soil features affecting—				
Road location	Water retention: Embankments	Water retention: Reservoir area	Agricultural drainage	Irrigation
Undulating to steep, few to many rock outcrops.	Fair stability subject to piping and cracking.	Moderate seepage, underlying material generally very porous.	Moderately rapid permeability.	Low to moderate water-holding capacity, moderately rapid intake rate.
Undulating to rolling to hilly with very steep side slopes; many rock outcrops on surface.	Material variable poor to good stability medium to high compressibility.	Low seepage underlying parent rock has many deep vertical fractures.	Slow permeability	High water-holding capacity moderate intake rate.
High plasticity, hardpan at a depth of 15 to 48 inches.	Poor to fair stability high compressibility, low strength.	Low seepage hardpan at a depth of 15 to 48 inches.	Very slow permeability	Low to moderate water-holding capacity depending on depth of hardpan; slow intake rate.
Most features favorable	Fair stability subject to piping and cracking.	Moderate to high seeping some of these soils have a clayey substratum and some are over loamy sand.	Moderately rapid permeability.	Low to moderate water-holding capacity moderately rapid intake rate.
Undulating to very steep, few to many rock outcrops.	Fair stability	Moderate seepage underlying material has many deep vertical fractures.	Moderate permeability	Moderate to high water-holding capacity, moderate intake rate.
Medium plasticity; moderately sloping to very steep; many rock outcrops in places.	Fair to good stability medium to high compressibility	Low seepage weathered bedrock below a depth of 32 inches.	Slow permeability	Low to moderate water-holding capacity, slow intake rate.
Medium plasticity below a depth of 1[illegible] inches	Fair to good stability, medium to high compressibility	Low to moderate seepage in places substratum material is sometimes composed of compact silts.	Moderately slow permeability	High water-holding capacity moderately slow intake rate.
Most features favorable	Fair stability subject to piping and cracking.	High seepage	Rapid permeability	Low water-holding capacity; rapid intake rate.
Most features favorable	Fair stability subject to piping and cracking	High seepage	Rapid permeability	Low water-holding capacity rapid intake rate.

[illegible]

TABLE 18.—*Engineering*

Soil series and map symbols	Suitability as source of—			Road fill	Hydrologic soil group
	Topsoil	Sand	Gravel		
Centerville: ChA, ChC, CxB, CxD.	Poor: Clay	Unsuitable: More than 80 percent material passing No. 200 sieve.	Unsuitable: Less than 10 percent gravel in profile.	Poor: A-7	D
Chino: Cl, Cm, Cn, Co, Cp, Cr, Cs.	Good to poor: Saline in places.	Poor to unsuitable: More than 35 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Poor to fair: A-4 and A-6.	B, drained.
Chualar: CtA, CtB.	Fair: Sandy clay loam.	Poor: More than 35 percent material passing No. 200 sieve.	Unsuitable: Less than 10 percent gravel in profile.	Fair and poor: A-4 and A-6.	B
Cibo: CuC, CuD, CuE, CvD, CvE, CvF, CwD, CwE.	Poor: Clay	Unsuitable: More than 80 percent material passing No. 200 sieve.	Unsuitable: Less than 10 percent gravel in profile.	Poor: A-7	D
Coarsegold: CxC, CxD, CxE, CxF, CyF.	Fair: Clay loam less than 40 inches thick.	Unsuitable: Mostly more than 55 percent material passing No. 200 sieve.	Unsuitable: Less than 15 percent gravel in profile.	Fair: A-4	C
Cometa: CzaB, CzaC, CzaD, CzbB, Czc. (For interpretations of San Joaquin soils in mapping unit CzcB, refer to San Joaquin series in this table.)	Fair to poor: Sandy loam and clay less than 14 inches thick.	Poor to unsuitable: 15 to 60 percent material passing No. 200 sieve to a depth between 17 and 38 inches and more than 65 percent below that depth.	Unsuitable: Less than 10 percent gravel in profile.	Fair in surface layer, A-4; poor below, A-7.	D
Delhi: DeA, DeB, DhA, DhB, DlA.	Poor: Loamy sand and sand.	Good to poor: 5 to 30 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Good: A-2 and A-3.	A
Dello: Dm, Dn.	Poor: Loamy sand and sand.	Good to poor: 5 to 35 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Good: A-1 and A-3.	A, drained; C, undrained.
Delpiedra: DoE, DpF, DsF. (For interpretations of Fancher soils in mapping unit DsF, refer to Fancher series in this table.)	Poor: Stony loam less than 12 inches thick.	Poor: 25 to 35 percent material passing No. 200 sieve.	Poor: 55 to 65 percent gravel 1 foot thick.	Poor: A-6	C
El Peco: Ec, Ed, Ep.	Poor: Saline-alkali moderately deep to hardpan.	Poor to unsuitable: 45 to 60 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Fair: A-4	C

interpretations—Continued

Road location	Water retention: Embankments	Water retention: Reservoir area	Agricultural drainage	Irrigation
High plasticity; moderately steep in places.	Fair to poor stability, low strength, high compressibility.	Low seepage; compact, silty sandy material below a depth of 32 inches.	Slow to very slow permeability.	High water-holding capacity; slow to very slow intake rate.
Medium plasticity.	Fair to good stability, medium to high compressibility; subject to settlement cracking.	Moderate to high seepage; underlying material is sand in some places.	Moderate permeability.	Moderate to high water-holding capacity; moderate intake rate.
Occupies depressional areas along small streams.	Fair stability.	Moderate seepage.	Moderately slow permeability.	High water-holding capacity; moderately slow intake rate.
High plasticity; steep; many rock outcrops.	Poor to fair stability, low strength, high compressibility.	Low seepage; weathered bedrock below a depth of 24 inches.	Slow permeability.	Low to high water-holding capacity; slow to moderately slow intake rate.
Medium plasticity; strongly sloping to very steep.	Fair stability; subject to piping and cracking; medium to high compressibility.	Moderate seepage; well-weathered bedrock below a depth of 32 inches.	Moderately slow permeability.	Low to high water-holding capacity; moderately slow intake rate.
Undulating to rolling; in places a temporary perched water table above the dense subsoil; high plasticity.	Surface layer has fair stability and is subject to piping and cracking; other layer has poor to good stability and medium to high compressibility.	Low seepage; clay layer at a depth of 18 inches.	Very slow permeability.	Low to very low water-holding capacity; moderate intake rate.
Most features favorable.	Fair stability; subject to piping and cracking.	High seepage.	Rapid and very rapid permeability.	Low to very low water-holding capacity; rapid intake rate.
High water table occurs along or recent flood plains of the local rivers.	Fair stability; subject to piping and cracking; underlying material has poor stability.	High seepage; these soils are in the bottom of wind-scoured hollows.	Very rapid permeability except when water table reaches the lowest of the depressions; then pond development is favorable.	Low water-holding capacity; rapid intake rate.
Steep to very steep slopes subject to land slipping and soil creep; a few outcrops of parent rock.	Fair stability; subject to piping; content of angular stone varies.	Moderate seepage; steeply dipping fracture planes in the bedrock.	Moderate permeability.	Very low water-holding capacity.
Most features favorable; hardpan at a depth of 18 to 36 inches.	Poor to fair stability; subject to piping and cracking.	Low seepage; hardpan at a depth of 18 to 36 inches.	Very slow permeability.	Low water-holding capacity; salts and sodium alkali may limit use of water by plants; moderately rapid intake rate.

TABLE 18.—*Engineering*

Soil series and map symbols	Suitability as source of— Topsoil	Sand	Gravel	Road fill	Hydrologic soil group
Exeter: Es, Et, Ex.	Fair: Sandy loam moderately deep to hardpan.	Unsuitable to poor: 35 to 55 percent material passing No. 200 sieve.	Unsuitable: Less than 5 percent gravel in profile.	Fair: A-4	C
Fallbrook: FaB, FaC, FaD, FaF, FaD, FbD, FcD, FcF, FdD, FdF, FeE.	Fair: Moderately deep sandy loam and sandy clay loam.	Poor to unsuitable: 25 to 45 percent material passing No. 200 sieve.	Unsuitable: Less than 5 percent gravel in profile.	Fair to good: A-2 and A-4	C
Fancher: Fn, FnE, FfE, FF. (For interpretations of Blasingame soils in mapping units FfF and FlF refer to Blasingame series in this table.)	Fair: Moderately deep gravelly clay loam.	Unsuitable: More than 55 percent material passing No. 200 sieve.	Unsuitable: Less than 30 percent gravel in profile.	Poor: A-6	C
Foster: Fm, Fn, Fo, Fp, Fr.	Fair to poor: Sandy loam salinity 4 to 15 in places.	Poor: 35 to 50 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Fair to good: A-2 and A-4	B, drained; C, undrained.
Fresno: Fs, Ft, Fu, Fv, Fw, Fx. (For interpretations of Traver soils in mapping unit Fx refer to Traver series in this table.)	Fair to poor: Moderately deep and shallow to hardpan, salinity is 0 to 30.	Unsuitable: More than 50 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Fair and poor: A-4 and A-6.	D: Ft, Fv, Fw. C: [illegible], Fx.
Friant: FyD, FyE.	Poor: Shallow fine sandy loam.	Poor: 35 to 45 percent material passing No. 200 sieve.	Unsuitable: Less than 15 percent gravel in profile.	Fair: A-4	D
Grangeville: Ga, Gd, Ge, Gf, Gg, Gt, Gk, Gl, Gm, Gn, Go, Gp.	Good, fine sandy loam; fair, sandy loam.	Poor to unsuitable: More than 30 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile in all units but Gl, the underlying material of which is gravel in places.	Good to fair: A-2 and A-4	B, drained; C, undrained.
Greenfield: GoA, GtA, GtB, GuA.	Fair: Sandy [illegible].	Poor: 30 to 40 percent material passing No. 200 sieve.	Unsuitable: Less than 10 percent gravel in profile.	Good to fair: A-2 and A-4	B
Hanford: Ha, Hb, Hc, Hd, He, Hf, Hg, Hh, Hk, Hl, Hm, Hn, Ho, Hp, Hr.	Good to fair: Fine sandy loam and sandy loam.	Fair to unsuitable: 15 to 55 percent material passing No. 200 sieve.	Poor to unsuitable: 0 to 40 percent gravel.	Good and fair: A-2 and A-4	B
Hesperia: Hsa, Hsc, Hsd, Hse, Hsm, Hsn, Hso, Hsp, Hsr, Hss, Hst, Hsy.	Good to poor: Saline in places.	Poor to unsuitable: More than 35 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Fair: A-4	B

interpretations—Continued

Soil features affecting—				
Road location	Water retention		Agricultural drainage	Irrigation
	Embankments	Reservoir area		
Most features favorable; hardpan at a depth between 12 and 36 inches.	Poor to fair stability, subject to piping and cracking.	Low seepage, hardpan at a depth of 12 to 36 inches.	Very slow permeability	Low water-holding capacity, moderately rapid intake rate.
Undulating to very steep; many large irregular outcrops of parent rock.	Fair stability; subject to piping and cracking.	Moderate seepage; deep well-weathered bedrock below a depth of 30 inches.	Moderate permeability	Low to very low water-holding capacity; moderate intake rate.
Steep to very steep, subject to land slipping and soil creep, high plasticity.	Fair to good stability, medium to high compressibility, common angular stones.	Low seepage, unweathered fractured bedrock below a depth of 48 inches.	Slow permeability	Low to moderate water-holding capacity
Most features are favorable, subject to high water table in some places.	Poor to fair stability subject to piping and cracking.	High seepage	Moderate to moderately rapid permeability, subject to high water table in some places.	Moderate to high water-holding capacity, moderately rapid intake rate, saline-alkali in some places.
Most features favorable; hardpan at a depth of 12 to 48 inches.	Fair stability; medium to high compressibility	Low seepage; hardpan at a depth of 12 to 18 inches.	Very slow permeability.	Low to moderate water-holding capacity; moderately slow intake rate; saline-alkali in most places.
Rolling to steep	Poor to fair stability subject to piping and cracking	Low seepage; slightly weathered bedrock below a depth of 12 inches.	Moderately rapid permeability	Very low water-holding capacity, moderately rapid intake rate
Most features favorable; occupies depressional areas along small streams in places.	Poor to fair stability subject to piping and cracking	High seepage	Moderately rapid permeability except when water table reaches the level of depressions adjacent to rivers, streams, and sloughs	Moderate to high water-holding capacity, moderately rapid intake rate, saline-alkali in places.
Most features favorable	Fair stability, subject to piping and cracking	High seepage; underlying material is moderately hard substratum in places.	Moderately rapid permeability.	Moderate to high water-holding capacity, moderately rapid intake rate
Most features favorable	Poor to fair stability subject to piping and cracking	High seepage; underlying material is compact silty or hard substratum in places.	Moderately rapid permeability	Low to high water-holding capacity, moderately rapid intake rate.
Most features favorable	Poor stability, subject to piping and cracking.	Moderate to high seepage; underlying material is compact silt at most places.	Moderately rapid to moderately slow permeability	Low to high water-holding capacity, moderately rapid to rapid intake rate; saline-alkali in some places.

TABLE 18.—*Engineering*

Soil series and map symbols	Suitability as source of— Topsoil	Sand	Gravel	Road fill	Hydrologic soil group
Hideaway: HfC	Unsuitable: Very shallow and extremely stony.	Unsuitable: Very shallow.	Unsuitable: Very shallow.	Fair: A-4	D
Hildreth: Hc	Poor: Clay.	Unsuitable: More than 70 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Poor: A-7	D
Holland: HvE	Fair: Sandy loam to sandy clay loam.	Poor to unsuitable: [illegible] to [illegible] percent material passing No. [illegible] sieve.	Unsuitable: Less than 5 percent gravel in profile.	Fair to poor: A-4 to A-[illegible].	B
Honcut: HwA, HwB, HyA, HzA.	Fair: Moderately deep to hard substratum.	Poor: 35 to [illegible] percent material passing No. 200 sieve.	Good: Underlying material is gravel in HyA; other units [illegible] less gravel in profile.	Good: A-2	B
Keefers: KeC, KfC	Poor: Mostly cobbly and stony.	Unsuitable: Clay to depth of [illegible] inches. Fair below 32 inches: 5 to 25 percent material passing No. 200 sieve.	Fair: Underlying material [illegible] 60 percent cobbly and gravelly rock colluvium over weathered bedrock.	Fair to poor: A-4 or A-7.	C
Keyes: K[illegible]C	Poor: Cobbly clay.	Poor: [illegible] to [illegible] percent material passing No. [illegible] sieve.	Poor to unsuitable: [illegible] deposit of compacted mixed gravel and [illegible] below the hardpan.	Good or poor: A-[illegible] or A-[illegible].	D
Los Robles: [illegible]	Fair: Clay loam.	Unsuitable to a depth of [illegible] inches: More than 25 percent material passing No. 2[illegible] sieve.	Underlying material is gravel in [illegible]; other units unsuitable: no gravel in profile.	Poor to good: A-[illegible], A-4, or A-2.	B
Madera: Ma, Mc, Md, Me	Poor: Hardpan at a depth of 24 to 18 inches.	Unsuitable: More than 40 percent material passing No. 200 sieve.	Unsuitable: Less than 5 percent gravel in profile.	Fair to poor: A-4, A-6, and A-7.	D
Merced: Mf, Mg, Mh, Mk, Ml, Mm	Poor: Clay and salinity.	Unsuitable: More than 85 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Poor: A-7	D
Millerton: MeD, MnE, MnF, MnE2, MoD, MoE, MoF	Poor: Shallow to bedrock.	Poor: 40 to 50 percent material passing No. 200 sieve.	Unsuitable: Less than 10 percent gravel in profile.	Fair: A-4	D

interpretations—Continued

Soil features affecting—				
Road location	Water retention: Embankments	Water retention: Reservoir area	Agricultural drainage	Irrigation
Moderately sloping [illegible] nearly vertical [illegible]; extremely stony in most places.	Fair stability; subject [illegible] extremely stony in most places.	Moderate seepage [illegible] weathered [illegible] below a depth of 2 to 10 inches.	Moderate permeab[illegible] [illegible] unweathered basalt below a depth of 3 to 10 inches.	Very low water-holding capacity; [illegible] slow intake rate.
High plasticity; [illegible] drainageways along the front of the foothills.	Poor to fair stability; low strength; high [illegible].	Low seepage; the underlying material may be [illegible] granitic rock, [illegible] sand, or coarse alluvium.	Slow permeability.	High water-holding capacity; slow intake rate.
Moderately steep to steep.	Fair to good stability; moderate to high [illegible].	Moderate seepage; the underlying [illegible] weathered [illegible] many feet thick.	Moderately slow permeability.	High water-holding capacity; moderately slow intake rate.
Most features favorable; [illegible] sloping in places.	Fair stability; subject to piping and cracking.	High seepage; underlying [illegible] strata in some places.	Moderately rapid permeability; underlying [illegible] in some places.	Moderate to high water-holding capacity; moderately rapid intake rate.
Gently sloping to moderately [illegible] fans in the foothill area; high plasticity.	Fair stability.	Low seepage; underlying [illegible] alluvium over weathered bedrock.	[illegible] permeability.	Low water-holding capacity; moderate intake rate.
Gently sloping to moderately [illegible] cobblestones on the surface; high plasticity.	Fair stability; medium to high [illegible].	Low seepage; hardpan [illegible] thick deposit of compact mixed gravel and cobblestones.	Very slow permeability.	Very low water-holding capacity; slow intake rate.
Nearly level to moderately sloping; [illegible] small streams, flood plains, or fans.	Fair stability; subject to piping and cracking.	Moderate seepage; [illegible] few places.	Moderate to moderately [illegible] permeability.	High to moderate water-holding capacity; [illegible] intake rate.
Nearly level alluvial fans; temporary perched water table often develops above the dense subsoil; high plasticity.	Poor to fair stability; [illegible] compressibility.	Low seepage; hardpan at a depth of 24 to 48 inches.	Very slow permeability.	Low to moderate water-holding capacity, depending on the soil depth; moderate intake rate.
Nearly level; high plasticity.	Poor to fair stability; low strength; high to very high compressibility.	Low seepage; [illegible] below a depth of 48 to 72 inches.	Slow and very slow permeability; [illegible] and widespread pumping have lowered the water table resulting in better drainage.	High water-holding capacity; [illegible] saline-alkali in some places.
Undulating to very [illegible] rocks on surface in a few places.	Poor to fair stability; subject to piping and cracking.	High seepage; weathered bedrock below a depth of 12 to 20 inches.	Moderately rapid permeability.	Very low water-holding capacity; moderately rapid intake rate.

TABLE 18.—*Engineering*

Soil series and map symbols	Suitability as source of— Topsoil	Sand	Gravel	Road fill	Hydrologic soil group
Montpellier: MnC, MnD	Fair: Coarse sandy loam and coarse sandy clay loam to a depth of 55 inches.	Poor: 25 to 50 percent material passing No. 200 sieve.	Unsuitable: Less than 10 percent gravel in profile.	Good to poor: A-2, A-6, underlying material good, A-2.	C
Mt. Olive: MtB, MtC	Poor: Clay	Unsuitable: More than 70 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Poor: A-7	C
Nord: No, Ns	Good to poor: Saline in places.	Unsuitable: More than 55 percent material passing No. 200 sieve.	Unsuitable: Less than 15 percent gravel in profile.	Fair to poor: A-4 or A-6.	B
Pachappa: Pa, Pc, Pd, Pe	Good to poor: Saline in places.	Unsuitable: More than 60 percent material passing No. 200 sieve.	Unsuitable: Less than 5 percent gravel in profile.	Poor to fair: A-4 or A-6.	B
Piper: PfB, PgB, PhB (For interpretations of Rossi soils in mapping unit PhB refer to Rossi series in this table.)	Poor: Sandy loam; salinity is 4 to 20.	Poor: 20 to 30 percent material passing No. 200 sieve.	Unsuitable: Less than 5 percent gravel in profile.	Good: A-2	B, drained; C, undrained.
Polinsky: PmB, PmC, PmD, PnB, PnC, PoC, PoD, PpC (For interpretations of Montpellier soils in mapping units PoC and PoD refer to Montpellier series in this table and for interpretations of Rocklin soils in mapping unit PpC refer to Rocklin series in this table.)	Fair: Consolidated sediments at a depth of 39 inches; sandy loam.	Poor: 40 to 50 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Fair: A-4	C
Pond: Pr, Ps, Pt, Pu, Pv, Pw	Poor: Salinity 4 to 70.	Fair to poor: Underlying material is sand in places.	Unsuitable: No gravel in profile.	Good to poor: A-2, A-4, and A-6.	B
Porterville: PxA, PxC, PyC, PzD	Poor: Clay that is cobbly and very very cobbly in places.	Unsuitable: More than 75 percent material passing No. 200 sieve.	Poor: 50 percent or more cobblestones in places; very cobbly unit, PzD, should be handled separately.	Poor: A-7	D
Positas: PzaB, PzaD, PzaE	Poor: Clay below a depth of 6 inches.	Unsuitable: Subsoil, other layers 35 to 65 percent material passing No. 200 sieve.	Poor to unsuitable: 15 to 35 percent gravel in profile.	Good to poor: A-2, A-4, and A-7.	D

interpretations—Continued

Road location	Soil features affecting— Water retention: Embankments	Soil features affecting— Water retention: Reservoir area	Agricultural drainage	Irrigation
Undulating to hilly	Fair stability; underlying material has fair stability but is subject to piping and cracking	Moderate seepage from coarse granitic sediment below a depth of 54 inches.	Slow permeability	Moderate water-holding capacity; moderate intake rate.
Gently sloping to strongly sloping; high plasticity	Poor to good stability high compressibility	Moderate seepage extremely calcareous weathered rock below a depth of 36 to 60 inches.	Slow permeability	Moderate to high water-holding capacity; slow intake rate.
Nearly level to gently undulating on flood plains of a few small streams along the foothills.	Poor stability; subject to piping and cracking	Moderate seepage, underlying material is cemented hard substratum in a few places.	Moderate permeability	High water-holding capacity, moderate intake rate; saline alkali in places.
Most features favorable	Fair stability	Moderate seepage, underlying material is unrelated compact silty substratum	Moderate to moderately slow permeability.	Moderate to high water-holding capacity; moderate intake rate, saline-alkali in places.
Most features favorable; nearly level to gently undulating.	Fair stability; subject to piping and cracking	High seepage below a depth of [illegible] inches these soils are stratified with moderately fine and fine textured material in many places.	Moderately rapid permeability.	Moderate water-holding capacity; moderately rapid intake rate, typically saline alkali
Undulating to moderately steep.	Fair stability; subject to piping and cracking.	Low seepage, underlying material is compact sediment	Moderately rapid permeability	Low to moderate water-holding capacity moderately rapid intake rate.
High plasticity	Fair to good stability, medium to high compressibility	Low to moderate seepage in compact silty substratum at a depth of 24 to 48 inches in places	Moderately slow permeability in compact silty substratum at a depth of 24 to 48 inches in places.	Low to moderate water-holding capacity; moderately slow intake rate; saline-alkali in most places.
Nearly level to moderately steep; high plasticity, cobbly in places	Poor to fair stability, low strength, high compressibility	Low seepage where rock occurs in the subsoil, reservoir seepage may be moderate	Slow permeability; surface becomes granular on drying and the soil cracks widely and deeply	Moderate to high water holding capacity; slow intake rate.
Undulating to steep; cobbly in most places, high plasticity.	Fair stability; high compressibility.	Low seepage, underlying material is compact, gravelly sandy loam.	Very slow permeability	Low to very low water-holding capacity; slow intake rate.

TABLE 18.—*Engineering*

Soil series and map symbols	Suitability as source of—				Hydrologic soil group
	Topsoil	Sand	Gravel	Road fill	
Ramona: Ra, Rb, Rc, Rd, Re	Fair: Sandy loam and sandy clay loam less than 40 inches thick.	Poor to unsuitable: 20 to 60 percent material passing No. 200 sieve.	Underlying material is gravel in Rd; other units unsuitable.	Poor to fair to a depth of 38 inches: A-4, A-6; good below a depth of 38 inches: A-2.	B
Redding: RlC, RgB	Poor: Clay at a depth of 9 inches.	Unsuitable: More than 40 percent material passing No. 200 sieve.	Unsuitable: Less than 30 percent gravel to hardpan; gravel below hardpan.	Good to poor: A-2, A-4, and A-7.	D
Rocklin: RkB, RlD	Fair: Hardpan at a moderate depth.	Poor: 30 to 55 percent material passing No. 200 sieve.	Unsuitable: Less than 10 percent gravel in profile.	Good to fair: A-2 and A-4.	C: RkB D: RlD
Rossi: Ro, Rs	Poor: Salinity is 1 to 50.	Poor to a depth of 12 inches, unsuitable below: 35 to 90 percent material passing No. 200 sieve.	Unsuitable: Less than 10 percent gravel in profile.	Fair to poor: A-4 and A-6.	C
San Joaquin: ScA, SdA, SdB, SeA, SfA, SgA, SgB, ShB. (For interpretations of Alamo soils in mapping unit ShB, refer to Alamo series in this table.)	Fair to poor: Hardpan at a depth of 12 to 48 inches.	Unsuitable: More than 35 percent material passing No. 200 sieve.	Underlying material is gravel in SfA; other units unsuitable, no gravel in profile.	Good to poor: A-2, A-4, A-6 and A-7.	D
Sesame: SkB, SkC, SkD, SlB, SlC	Fair: Weathered rock at a depth of 30 inches.	Poor: 35 to 60 percent material passing No. 200 sieve.	Unsuitable: Less 10 percent gravel in profile.	Fair: A-4	C
Shaver: SmE	Fair: Coarse sandy loam.	Poor: 25 to 35 percent material passing No. 200 sieve.	Unsuitable: Less than 15 percent gravel in profile.	Good: A-2	B
Sierra: SnC, SnD, SnE, SnF, SoD, SoE, SrE, StF. (For interpretations of Tollhouse soils in mapping unit StF, refer to Tollhouse series in this table. StF includes Rock land, described under Granitic rock land in text.)	Fair: Clay loam and sandy clay loam.	Poor to unsuitable: 40 to 70 percent material passing No. 200 sieve.	Unsuitable: Less than 15 percent gravel in profile.	Fair to poor: A-4 and A-6.	B
Temple: Ta, Tb, Tc, Td, Te, Tf, Tg	Fair to poor: Clay and clay loam, salinity is 0 to 15.	Unsuitable to a depth of 31 inches, more than 65 percent material passing No. 200 sieve; poor below that depth, 20 to 35 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Poor in surface layer, A-6; good in underlying material, A-2.	B

interpretations—Continued

Soil features affecting—				
Road location	Water retention: Embankments	Water retention: Reservoir area	Agricultural drainage	Irrigation
Most features favorable	Fair stability	Moderate seepage, underlying material is gravel or hard substratum at a depth of 24 to 48 inches in places.	Moderately slow permeability, underlying material is hard substratum in places.	Moderate to high water-holding capacity, moderate intake rate.
Gently sloping to strongly sloping, hardpan at a depth of 12 to 36 inches, gravelly in most places.	Fair stability	Low seepage, hardpan at a depth of 12 to 36 inches.	Very slow permeability, hardpan at a depth of 12 to 36 inches	Very low to low water-holding capacity, moderate intake rate.
Gently sloping to moderately steep, hardpan at a depth between 10 and 36 inches.	Fair stability; medium to high compressibility.	Low seepage, hardpan at a depth of 10 to 36 inches.	Very slow permeability, hardpan at a depth of 10 to 36 inches.	Very low to low water holding capacity; moderate intake rate.
High plasticity	Fair to good stability, medium to high compressibility.	Low seepage	Slow permeability	Moderate to high water-holding capacity; slow to moderate intake rate, saline-alkali in most places.
Most features favorable; nearly level to slightly undulating, hardpan at a depth of 12 to 48 inches.	Fair to good stability; medium to high compressibility	Low seepage, hardpan at a depth of 12 to 48 inches, underlying material is weakly cemented granitic alluvium	Very slow permeability; hardpan at a depth of 12 to 48 inches.	Very low to moderate water-holding capacity, moderately slow to moderate intake rate.
Undulating to moderately steep.	Fair stability; medium to high compressibility.	Moderate seepage, underlying material is deeply weathered bedrock.	Moderately slow permeability.	Low to moderate water-holding capacity, moderately slow intake rate.
Moderately steep and steep.	Fair stability; subject to piping and cracking.	High seepage, underlying material is deeply weathered rock.	Moderately rapid permeability.	Moderate water-holding capacity; moderately rapid intake rate.
Rolling to very steep; many rocks on surface, many outcrops of parent rock.	Fair stability; medium to high compressibility	Moderate seepage, underlying material is deeply weathered bedrock.	Moderately slow permeability	Moderate to high water holding capacity; moderately slow intake rate.
Most features favorable; medium plasticity.	Fair stability; surface layer has medium to high compressibility; underlying material is subject to piping and cracking.	Low seepage, commonly stratified and coarser textured underlying material.	Moderately slow permeability.	High water holding capacity; slow to moderately slow intake rate, saline-alkali in places.

TABLE 18.—*Engineering*

Soil series and map symbols	Suitability as source of—				Hydrologic soil group
	Topsoil	Sand	Gravel	Road fill	
Tivy: TkB, TkC, TkE, [illegible], TlD, TlF.	Fair: Loam to a depth of 26 inches.	Unsuitable: [illegible]0 to 60 percent material passing No. 200 sieve.	Unsuitable: Less than 15 percent gravel in profile.	Fair: A-4	C
Tollhouse: TmF	Poor: Coarse sandy loam to a depth of 18 inches, but rock below that depth.	Fair to poor: 15 to 30 percent material passing No. 200 sieve.	Poor to unsuitable: 15 to 30 percent gravel in profile.	Good: A-2	D
Toomes: TnF	Poor: Rock at a depth of 8 inches.	Unsuitable: Very shallow.	Unsuitable: Very shallow.	Fair: A-4	D
Trabuco: ToC, ToD, ToF, TpF, TpE, TpF.	Fair: Rock at a depth of 30 inches.	Unsuitable: 55 to 75 percent material passing No. 200 sieve.	Unsuitable: Less than 15 percent gravel in profile.	Poor to fair: A-4 and A-6.	C
Traver: Tr, Ts, Tt, Tu	Good to poor: Salinity [illegible] to 50.	Poor to unsuitable: 35 to 60 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Fair: A-4	B
Tretten: TvC, TvD, TvE, TvF, TwF	Fair: Fine sandy loam to a depth of 36 inches, but rock below that depth.	Unsuitable: More than 50 percent material passing No. 200 sieve.	Unsuitable: Less than 10 percent gravel in profile.	Fair: A-4	C
Trimmer: TxC, TxD, TxE, TxF, TyE, TyF, TzE, TzF. (For interpretations of Tretten soils in mapping units TzE and TzF refer to Tretten series in this table.)	Fair: Weathered rock at a depth of 31 inches.	Poor to unsuitable: More than [illegible] percent material passing No. 200 sieve.	Unsuitable: Less than 10 percent gravel in profile.	Poor to fair: A-4 and A-6.	C
Tujunga: TzaA, TzbA, TzbB, TzcA, TzdA, [illegible].	Poor: Loamy sand and sand (cobbly in places).	Good to poor: 5 to 3[illegible] percent material passing No. 200 sieve.	Poor to unsuitable: 10 to 40 percent gravel and cobblestones.	Good: A-1 or A-2 and A-3	A
Visalia: VaA, VaB, VbA, VcA	Fair: Sandy loam.	Poor: 30 to 40 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Good to fair: A-2 or A-4	B
Vista: VfB, VfC, VfD, VfE, VfF, VgB, VgD, VgE, VkC, VkE, VkF, VlD, VlF, VmD, VnD, VoD, VoE, VsF. (For interpretations of Fallbrook soils in mapping units VnD through VsF refer to Fallbrook series in this table.)	Fair: 30 inches of coarse sandy loam to rock.	Poor: 25 to 35 percent material passing No. 200 sieve.	Unsuitable: Less than 15 percent gravel in profile.	Good: A-2	C

interpretations—Continued

Soil features affecting				
Road location	Water retention		Agricultural drainage	Irrigation
	Embankments	Reservoir area		
Undulating to very steep; many rocks on surface; a few outcrops of parent rock.	Fair stability	Moderate seepage; weathered bedrock below a depth of 10 to 48 inches.	Moderate permeability	Low water-holding capacity; moderate intake rate.
Steep to very steep; many rocks on surface; many outcrops of parent rock.	Fair stability; subject to piping and cracking.	High seepage; weathered bedrock below a depth of 20 inches.	Rapid permeability	Very low water-holding capacity; moderately rapid intake rate.
Basaltic mudflow, steep to very steep; many cobblestones on surface.	Fair stability; subject to piping.	Low seepage; underlying very hard dense mudflow material is 5 to 8 feet thick.	Moderate permeability	Very low water-holding capacity.
Rolling to very steep; many rocks on surface; many outcrops of parent rock on steep slopes; high plasticity.	Fair stability; medium to high compressibility.	Moderate seepage; weathered bedrock below a depth of 30 to 70 inches.	Slow permeability	Low to moderate water-holding capacity; moderately slow intake rate.
Most features favorable.	Fair stability	Moderate seepage, compact clay layers in most places.	Moderate permeability	Moderate water-holding capacity, moderate to moderately rapid intake rate, saline-alkali in most places.
Undulating to very steep; many rocks on surface; many outcrops of parent rock on steep slopes.	Fair stability; medium to high compressibility, subject to piping and cracking.	Moderate seepage; deeply weathered bedrock below a depth of 24 to 40 inches.	Moderate permeability	Low to moderate water-holding capacity; moderate intake rate.
Undulating to very steep; a few to many rocks on surface; many outcrops of parent rock on steep slopes.	Fair stability, medium to high compressibility.	Moderate seepage; deeply weathered bedrock below a depth of 24 to 48 inches.	Moderately slow permeability	Low to moderate water-holding capacity; moderate intake rate.
Nearly level, and on small flood plains along streams.	Poor to fair stability, subject to piping and cracking.	High seepage	Rapid to very rapid permeability	Low to very low water-holding capacity; rapid intake rate.
Nearly level to moderately sloping and on small flood plains along streams.	Fair stability; subject to piping and cracking.	High seepage	Moderately rapid permeability	High water-holding capacity; moderately rapid intake rate.
Undulating to very steep; many outcrops of parent rock.	Fair stability; subject to piping and cracking.	High seepage; underlying material is weathered bedrock to a depth of several feet.	Moderately rapid permeability	Very low to low water-holding capacity; moderately rapid intake rate.

TABLE 18.—*Engineering*

Soil series and map symbols	Suitability as source of—				Hydrologic soil group
	Topsoil	Sand	Gravel	Road fill	
Wankena: Wa, Wo	Poor: Salinity is 4 to 50.	Poor to unsuitable: 35 to 60 percent material passing No. 200 sieve.	Unsuitable: Less than 10 percent gravel in profile.	Poor to fair: A-4 and A-6	D
Wisheylu: WhB, WhD, WhE, WhF, WrD	Good to fair: Loam and clay loam to a depth of 40 inches.	Unsuitable: More than 55 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Fair to poor: A-4 and A-6	C
Wunjey: Ws, Wu	Poor: Salinity is 4 to 50.	Unsuitable: More than 80 percent material passing No. 200 sieve.	Unsuitable: No gravel in profile.	Fair: A-4	B
Yokohl: YhA, YhB, YkA, YkB, YlD, YmA	Poor: Clay at a depth of 10 inches; hard pan at 14 inches.	Unsuitable: More than 60 percent material passing No. 200 sieve.	Poor to unsuitable: Less than 35 percent gravel in profile.	Poor: Mostly A-6 and A-7.	D: YhA, YhB, YlD. C: YkA, YkB, YmA.

Engineering classification systems

Soil scientists of the U.S. Department of Agriculture classify soils according to texture. In some ways this system is comparable to the two systems used by engineers for classifying soils, that is, the system approved by the American Association of State Highway Officials (AASHO) (1) and the Unified system adopted by the Corps of Engineers, U.S. Army (33). Following are descriptions of the systems used by engineers.

Most highway engineers classify soil materials in accordance with the AASHO system. In this system soil material is classified in seven principal groups. The groups range from A-1 (gravelly soils having high bearing capacity, the best soils for subgrade) to A-7 (clayey soils having low strength when wet, the poorest soils for subgrade). Within each group the relative engineering value of the soil material is indicated by a group index number. Group index numbers range from 0 for the best materials to 20 for the poorest. The group index number for the soils tested is shown in parentheses after the soil group symbol in table 16.

Some engineers prefer to use the Unified system for classifying soils. In this system soil materials are identified as coarse grained, eight classes; fine grained, six classes; and highly organic. In the Unified system the symbols GM, GC, SM, and SC represent gravel or sand with fines of silt and clay; ML and CL, silt and clay of low liquid limit; CH and MH silt and clay of high liquid limit; and GP, GM, SP, and SM, sand, gravel, and mixtures of gravel and sand. Some soil materials have characteristics that are borderline between the major classes and are given a borderline classification, such as CL-ML. Table 16 shows the classification of the tested soils according to the Unified system.

Engineering test data

Table 16 gives test data for samples of selected layers taken from the profiles of some extensive soils of the survey area. The samples were taken in representative sites. Some of the soils were tested in the laboratory of the California Division of Highways. Others were tested in the Arcadia Materials Testing Laboratory of the U.S. Forest Service. The data in the table show the classification of the samples under the AASHO and Unified systems. They also show the moisture density, mechanical analyses, liquid limit, plasticity index, and bulk density.

In the *moisture-density*, or compaction test, a sample of the soil material is compacted several times with a constant compactive effort, each time at a successively higher moisture content. The moisture content increases until the optimum moisture content is reached. After that the density decreases with increase in moisture content. The highest density obtained in the compaction test is termed "maximum density." Moisture-density data are important in construction, for as a rule, optimum stability is obtained if the soil is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

The results of the mechanical analysis may be used to determine the relative proportions of the different size particles that make up the soil sample.

The tests for liquid limit and plastic limit measure the effect of water on consistence of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The *plastic limit* is the moisture content at which the soil material passes from a semisolid

interpretations—Continued

Soil features affecting—				
Road location	Water retention		Agricultural drainage	Irrigation
	Embankments	Reservoir area		
Most features favorable	Fair stability; medium to high compressibility.	Low seepage	Very slow permeability	Very low to low water-holding capacity; slow intake rate; saline-alkali in most places.
Rolling to very steep, few outcrops of parent rock.	Fair to good stability, medium to high compressibility.	Low seepage, deeply weathered bedrock below a depth of 30 to 60 inches	Slow permeability	Moderate to high water-holding capacity, slow intake rate.
Most features favorable	Fair stability	Moderate seepage, compact silty substratum at a depth of 24 to 42 inches in some places.	Moderate permeability	High water-holding capacity, moderate intake rate; saline-alkali in most places.
Hardpan at a depth of 12 to 40 inches; high plasticity.	Fair stability, high compressibility.	Low seepage, hardpan at a depth of 12 to 40 inches.	Very slow permeability, hardpan at a depth of 12 to 40 inches.	Very low to low water-holding capacity, slow to moderately slow intake rate.

to a plastic state. The *liquid limit* is the moisture content at which the soil material passes from a plastic to a liquid state. The *plasticity index* is the numerical difference between liquid limit and plastic limit. It indicates the range in moisture content within which a soil material is in a plastic condition.

Bulk density, expressed in pounds per cubic foot, is the mass per unit bulk volume of soil that has been dried to a constant weight at 105° C. The bulk volume is the volume of an arbitrary soil mass, including the volume of the solid particles and of the pores. The pores are the interstices, or voids, between the solid particles.

Engineering properties

Table 17 lists the soil series in the survey area, lists the map symbols for each mapping unit, and gives estimates of soil properties significant to some engineering work.

Given in table 17 are the depth to weathered or hard bedrock or a hardpan, depth to seasonal high water table, shrink-swell potential, and the estimated USDA, Unified, and AASHO classifications. In addition estimates of the percentages of material passing through the various sieves are given. Also shown are estimates of permeability, available water capacity, reaction, and salinity. The estimates are based partly on examinations made in the field and partly on results of test data shown in table 16. Since the estimates are only for typical soils, considerable variation from these values should be anticipated. More information on the range of properties of the soils can be obtained in other parts of this survey, particularly in the section "Descriptions of the Soils."

Depth to bedrock or a hardpan, expressed in feet, gives the observed or estimated range of depth from the surface to weathered or unweathered bedrock or a hardpan.

Depth to seasonal high water table, expressed in feet, gives the observed or estimated range of depth from the surface to the shallowest level reached by a seasonal water table.

The shrink-swell potential refers to the change in volume of the soil that results from a change in moisture content. It is estimated on the basis of the amount and type of clay in the soil layers.

The columns headed "Percentage passing sieve" list the estimated range in percentage of material passing sieve numbers 4, 10, and 200. It should not be assumed that all samples of a specific soil will fall within the range of the typical profile shown or that the engineering classification will be the same as shown. The range of estimated physical properties is broad for some of the soils, and as a result the soils may be in several classification groups.

Soil permeability is the ability of a soil to transmit air or water. The rates given in table 17 are for the soils as they occur in place.

Available water capacity, expressed in inches per inch of soil depth, is the capacity of a soil to retain water that can be readily absorbed by plants. It is the estimated amount of water held in a soil between field capacity and the permanent wilting point of plants.

Reaction as shown in table 17 is the estimated range in pH values for each major horizon as determined in the field. It indicates the acidity or alkalinity of the soils. A pH of 7, for example, indicates a neutral soil, lower pH value indicates acidity, and a higher value indicates alkalinity.

Salinity of a soil is based on the electrical con-

ductivity of saturated soil extract as expressed in millimhos per centimeter at 25° C. Values less than 4 indicate a soluble salt content of less than 0.3 percent by air-dry weight of soil

Engineering interpretations

Table 18 rates the soils according to their suitability as a source of topsoil, sand, gravel, and road fill. Then the hydrological soil group is given, followed by features that affect the suitability of the soils as sites for roads, water retention structures, agricultural drainage, and irrigation systems. Basic igneous rock land, Colluvial land, Granitic rock land, Pits, Playas, Riverwash, Sandy alluvial land, Sandy alluvial land, leveled, and Terrace escarpments are not listed in the table. These land types are too variable in characteristics to be rated or otherwise are not suitable for engineering

Because the estimates in table 18 are for a typical profile, some variations from the values given should be expected. A description of a typical profile for each series in the survey area is in the section "Descriptions of the Soils."

The ratings used for soils as a source of topsoil, sand, gravel, and road fill are *good*, *fair*, *poor*, or *unsuitable*.

Ratings of the soils as a source of topsoil are for use on slopes, shoulders of roads, and along ditches. The ratings are according to suitability of the soils for growth of vegetation.

In rating the soils as a source of sand and gravel, their suitability as a source of construction material was considered. Suitability for specific engineering use of the soils must be determined by onsite investigation. The suitability of the soils for use as road fill was based on estimates of the appropriate soil properties in table 18, and on test data in table 16.

Engineers and soil scientists have classified the soil series in the survey area into four hydrologic groups. The grouping is based on estimates of the intake of water during the latter part of a storm of long duration, after the soil profile is wet and has an opportunity to swell, without the protective effect of any vegetation. The grouping is tentative and subject to change as further data and experience are gained. The four groups are

Group A consists of soils that have a high infiltration rate when thoroughly wetted. These soils have a high rate of water transmission and low runoff potential. They are deep, are well drained or excessively drained, and consist chiefly of sand, gravel, or both.

Group B soils have a moderate infiltration rate when thoroughly wetted. These soils have a moderate rate of water transmission and moderate runoff potential. They are moderately deep or deep, are moderately well drained or well drained, and are medium textured to moderately coarse textured

Group C soils have a slow infiltration rate when thoroughly wetted. These soils have a slow rate of water transmission, and high runoff potential. They have a layer that impedes downward movement of water, or they are moderately fine textured or fine textured and have a slow infiltration rate.

Group D soils have a very slow infiltration rate when thoroughly wetted. The rate of water transmission is very slow, and runoff potential is very high. In this group are (1) clay soils that have high shrink-swell

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
AaA	Academy loam, 0 to 3 percent slopes.	Moderate: Hard sandy clay loam.	Severe: Slow permeability	Moderate: Well drained clay loam.
AaB	Academy loam, 3 to 9 percent slopes.	Moderate: Hard sandy clay loam.	Severe: Slow permeability	Moderate: Well drained clay loam.[2]
AcB	Ahwahnee coarse sandy loam, 3 to 9 percent slopes.	Moderate: Hard coarse sandy loam.	Slight to moderate: Slopes	Low
AcC	Ahwahnee coarse sandy loam, 9 to 15 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
AcD	Ahwahnee coarse sandy loam, 15 to 30 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
AcE	Ahwahnee coarse sandy loam, 30 to 45 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
AdD	Ahwahnee very rocky coarse sandy loam, 3 to 30 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes, rock outcrops.	Low
AdE	Ahwahnee very rocky coarse sandy loam, 30 to 45 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low

potential; (2) soils that have a permanent high water table; (3) soils that have a claypan or clay layer at or near the surface; and (4) soils that are shallow over nearly impervious material.

Some of the features that affect the location of roads are topography, rock outcrops, and plasticity.

In locating a suitable site for farm ponds and reservoirs, the presence of suitable material for the core and embankment are the chief considerations. Soils that are resistant to piping and settlement cracking, that are readily compressible, that have a low seepage rate, and that are slowly permeable are desirable as sites. Features that would adversely affect the location of a farm pond or reservoir, such as substratum and underlying material, are also given.

Internal soil drainage is expressed in terms of the relative permeability of the soil material. It is based on the soil permeability classes as used by the Soil Conservation Service (27). Commonly the percolation rate of a soil is based on the least permeable horizon in the solum or immediate substratum.

Suitability of a soil for irrigation is based chiefly on its rate of intake and its water-holding capacity. Also considered are permeability, need for leaching, soil depth, presence of salts or alkali, and textural classification of the soil profile. The intake rate is the rate of irrigation water movement into and through the root zone.

Nonfarm Uses of the Soils

The information in this section is useful to farmers and to planners. It is also useful to builders, to landscape architects, realtors, potential landowners, and others interested in the use of the soils in the Eastern Fresno Area for purposes other than farming. The survey area is rapidly increasing in population, because the suburbs of the cities, mainly Fresno and Clovis, are steadily expanding into areas formerly used for farming. Consequently the demand for housing developments, shopping centers, schools, parks, playgrounds, golf courses, and other recreational areas also is increasing.

In selecting a site for a home, a highway, an industry, recreational use, or other nonfarm purposes, the suitability of the soils in each site for such use must be determined. Some of the more common properties affecting the use of the soils for nonfarm purposes are soil texture, permeability, salinity and alkalinity; degree of slope; presence of stones or rocks; drainage, depth to the water table; and hazard of flooding. On basis of these and related characteristics, soil scientists and engineers have rated each soil in the survey for certain nonfarm uses. The ratings are given in table 19, and the method of deriving them is explained in the paragraphs that follow.

The ratings in table 19 are based on the properties and qualities of the soils and do not include other features that may be important in selecting an area for a specific use. They are not a substitute for the detailed information that can be obtained by reading the descriptions of soil series and mapping units in this publication. Also, for most projects, an investigation should be made at all places seriously considered as a site for construction.

soils for nonfarm uses

Landscaping	Cottages, utility buildings, shelters	Recreation: Campgrounds, picnic areas	Recreation: Playgrounds, athletic fields
Severe: Slow subsoil permeability.	Moderate: Moderate foundation support; slow subsoil permeability.	Slight.	Severe: Slow subsoil permeability.
Severe: Slow subsoil permeability.	Moderate: Moderate foundation support; slow subsoil permeability.	Moderate: Slopes.	Severe: Slopes, slow subsoil permeability.
Slight to moderate: Slopes; low to medium available water holding capacity.	Moderate: Moderate foundation support.	Moderate: Slopes.	Severe: Slopes.
Moderate: Slopes; low to medium available water holding capacity.	Moderate: Slopes; moderate foundation support.	Severe: Slopes.	Severe: Slopes.
Severe: Slopes.	Severe: Slopes.	Severe: Slopes.	Severe: Slopes.
Very severe: Slopes.	Very severe: Slopes.	Very severe: Slopes.	Very severe: Slopes.
Severe: Rockiness.	Severe: Rockiness.	Moderate to severe: Slopes.	Severe: Slopes, rockiness.
Very severe: Slopes.	Very severe: Slopes.	Very severe: Slopes.	Very severe: Slopes.

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
AdF	Ahwahnee very rocky coarse sandy loam, 45 to 70 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
AeD	Ahwahnee very rocky coarse sandy loam, shallow, 3 to 30 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes, rock outcrops.	Low
AeF	Ahwahnee very rocky coarse sandy loam, shallow, 30 to 70 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
AhD	Ahwahnee-Sierra coarse sandy loams, 15 to 30 percent slopes.[2]			
AhE	Ahwahnee-Sierra coarse sandy loams, 30 to 45 percent slopes.[2]			
AhF	Ahwahnee-Tollhouse-Rock land complex, 45 to 70 percent slopes.[2]			
AkB	Aiken loam, 3 to 9 percent slopes.	Slight	Severe: Slow permeability	High: Well drained clay [3]
AmF	Aiken very rocky loam, 45 to 70 percent slopes.	Slight	Severe: Slow permeability	High: Well-drained clay [3]
An	Alamo clay.	Moderate: Hard expanding clay	Severe: Very slow permeability	High: Poorly drained clay
AoA	Atwater loamy sand, 0 to 3 percent slopes.	Moderate: Slightly hard loamy sand	Slight	Low
AoB	Atwater loamy sand, 3 to 9 percent slopes.	Moderate: Slightly hard loamy sand	Moderate: Slopes	Low
ApA	Atwater loamy sand, moderately deep, 0 to 3 percent slopes.	Moderate: Slightly hard loamy sand	Severe: Slow permeability	Low
ArA	Atwater sandy loam, 0 to 3 percent slopes.	Moderate: Slightly hard loamy sand.	Slight	Low
ArB	Atwater sandy loam, 3 to 9 percent slopes.	Moderate: Slightly hard loamy sand.	Moderate: Slopes	Low
AsA	Atwater sandy loam, clay substratum, 0 to 3 percent slopes.	Moderate: Slightly hard loamy sand.	Severe: Very slow permeability	Low
AtA	Atwater sandy loam, moderately deep, 0 to 3 percent slopes.	Moderate: Hard sandy loam.	Severe: Slow permeability	Low
AuB	Auberry coarse sandy loam, 3 to 9 percent slopes.	Moderate: Hard sandy loam.	Moderate: Moderate permeability	Moderate: Well-drained sandy clay loam [3]
AuB2	Auberry coarse sandy loam, 3 to 9 percent slopes, eroded	Moderate: Hard sandy loam	Moderate: Moderate permeability.	Moderate: Well-drained sandy clay loam [3]
AuC	Auberry coarse sandy loam, 9 to 15 percent slopes.	Moderate: Hard sandy loam.	Severe: Slopes	Moderate: Well-drained sandy clay loam.[3]
AuC2	Auberry coarse sandy loam, 9 to 15 percent slopes, eroded	Moderate: Hard sandy loam.	Severe: Slopes	Low to moderate: Well drained sandy clay loam.[3]
AuD	Auberry coarse sandy loam, 15 to 30 percent slopes.	Moderate: Hard sandy loam.	Severe: Slopes	Moderate: Well-drained sandy clay loam.[3]

soils for nonfarm uses—Continued

Landscaping	Recreation: Cottages, utility buildings, shelters	Recreation: Campgrounds, picnic areas	Recreation: Playgrounds, athletic fields
Very severe: Slopes.	Very severe: Slopes.	Very severe: Slopes.	Very severe: Slopes.
Severe: Soil depth, rockiness.	Severe: Rockiness.	Moderate to severe: Slopes.	Severe: Slopes, rockiness.
Very severe: Slopes; moderate soil depth.	Very severe: Slopes.	Very severe: Slopes.	Very severe: Slopes.
Moderate: Slow subsoil permeability.	Moderate to severe: Poor foundation support; slow subsoil permeability.	Severe: Loam surface layer, dusty.	Severe: Slopes; slow subsoil permeability.
Very severe: Slopes.	Very severe: Slopes, slow subsoil permeability.	Very severe: Slopes.	Very severe: Slopes.
Very severe: Very slow subsoil permeability; poor surface drainage.	Severe: Very slow subsoil permeability; ponding.	Severe: Clay surface layer, ponding.	Severe: Clay surface layer; very slow subsoil permeability; ponding.
Severe: Low available water holding capacity.	Moderate to severe: Moderate foundation support.	Moderate: Loamy sand surface layer.	Moderate: Loamy sand surface layer.
Severe: Low available water holding capacity.	Moderate to severe: Moderate foundation support.	Moderate: Slopes, loamy sand surface layer.	Severe: Slopes.
Severe: Low available water holding capacity.	Moderate to severe: Moderate foundation support.	Moderate: Loamy sand surface layer.	Severe: Slow permeability, loamy sand surface layer.
Slight.	Moderate to severe: Moderate foundation support.	Very slight.	Slight.
Slight to moderate: Slopes.	Moderate to severe: Moderate foundation support.	Moderate: Slopes, erosion hazard.	Severe: Slopes.
Moderate: Moderate soil depth to clay substratum.	Moderate to severe: Moderate foundation support; very slow substratum permeability.	Slight.	Severe: Very slow substratum permeability.
Moderate: Moderate soil depth to compact substratum.	Moderate: Moderate foundation support.	Very slight.	Severe: Slow permeability.
Slight to moderate: Slopes.	Moderate: Moderate foundation support; erosion hazard.	Moderate: Slopes, erosion hazard.	Severe: Slopes.
Slight to moderate: Slopes, eroded surface layer.	Moderate: Moderate foundation support; erosion hazard.	Moderate: Slopes, erosion hazard.	Severe: Slopes.
Moderate: Slopes.	Moderate: Moderate foundation support; slopes.	Severe: Slopes.	Severe: Slopes.
Moderate: Slopes; eroded surface layer.	Moderate: Moderate foundation support; slopes.	Severe: Slopes.	Severe: Slopes.
Severe: Slopes.	Severe: Slopes.	Severe: Slopes.	Severe: Slopes.

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
AuD2	Auberry coarse sandy loam, 15 to 30 percent slopes, eroded.	Moderate: Hard sandy loam.	Severe: Slopes	Moderate: Well-drained sandy clay loam.[2]
AuE	Auberry coarse sandy loam, 30 to 45 percent slopes.	Moderate: Hard sandy loam.	Severe: Slopes	Moderate: Well-drained sandy clay loam.[2]
AuF	Auberry coarse sandy loam, 45 to 70 percent slopes.	Moderate: Hard sandy loam.	Severe: Slopes	Moderate: Well-drained sandy clay loam.[2]
AvD	Auberry very rocky coarse sandy loam, 3 to 30 percent slopes.	Moderate: Hard sandy loam.	Severe: Slopes, rockiness	Moderate: Well-drained sandy clay loam.[2]
AvE	Auberry very rocky coarse sandy loam, 30 to 45 percent slopes.	Moderate: Hard sandy loam.	Severe: Slopes	Moderate: Well-drained sandy clay loam.
AvF	Auberry very rocky coarse sandy loam, 45 to 70 percent slopes.	Moderate: Hard sandy loam.	Severe: Slopes	Moderate: Well-drained sandy clay loam.[2]
AwF	Auberry very rocky coarse sandy loam, shallow, 30 to 70 percent slopes.	Moderate: Hard sandy loam.	Severe: Slopes	Moderate: Well-drained sandy clay loam.
AxD	Auberry-Sierra coarse sandy loams, 15 to 30 percent slopes.[4]			
AxE	Auberry-Sierra coarse sandy loams, 30 to 45 percent slopes.[4]			
AxF	Auberry-Sierra coarse sandy loams, 45 to 70 percent slopes.[4]			
AyF	Auberry-Sierra very rocky coarse sandy loams, 45 to 70 percent slopes.[4]			
AzF	Auberry-Tollhouse-Rock land complex, 30 to 70 percent slopes.[4]			
BaF	Basic igneous rock land.	Variable: Rock at a depth of less than 12 inches.	Very severe: Very shallow soil.	Low.
BcC	Blasingame loam, 3 to 15 percent slopes.	Moderate: Very hard clay loam.	Severe: Slow permeability	Moderate: Well-drained clay loam.[2]
BcD	Blasingame loam, 15 to 30 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, slow permeability.	Moderate: Well-drained clay loam.[2]
BcE	Blasingame loam, 30 to 45 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, slow permeability.	Low to moderate: Well-drained clay loam.[2]
BcF	Blasingame loam, 45 to 70 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, slow permeability.	Moderate.
BdF	Blasingame loam, shallow, 45 to 70 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, slow permeability.	Moderate: Well-drained clay loam.[2]
BgD	Blasingame very rocky loam, 3 to 30 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes; rockiness	Moderate: Well-drained clay loam.[2]
BgF	Blasingame very rocky loam, 45 to 70 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes	Moderate: Well-drained clay loam.[2]

soils for nonfarm uses—Continued

Landscaping	Recreation		
	Cottages, utility buildings, shelters	Campgrounds, picnic areas	Playgrounds, athletic fields
Severe: Slopes	Severe: Slopes	Severe: Slopes	Severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Severe: Rockiness	Moderate to severe: Rockiness.	Moderate to severe: Slopes	Severe: Slopes, rockiness.
Very severe: Slopes	Very severe: Slopes; rockiness.	Very severe: Slopes	Very severe: Slopes, rockiness.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes
Very severe: Slopes, shallow	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Rockiness	Very severe: Rockiness	Very severe: Rockiness	Very severe: Slopes, rockiness.
Severe: Slow subsoil permeability	Moderate: Moderate foundation support, erosion hazard.	Moderate to severe: Slopes	Severe: Slopes.
Severe: Slopes, slow subsoil permeability.	Severe: Slopes	Severe: Slopes	Severe: Slopes.
Very severe: Slopes, slow subsoil permeability.	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes, slow subsoil permeability	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes, slow subsoil permeability	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Severe: Slow subsoil permeability, rockiness.	Moderate to severe: Rockiness, erosion hazard.	Moderate to severe: Slopes, erosion hazard.	Severe: Slopes, rockiness
Very severe: Slopes, slow subsoil permeability, rockiness.	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
BkF	Blasingame extremely rocky loam, shallow, 30 to 70 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes	Moderate: Well-drained clay loam.[2]
BlD	Blasingame clay loam, shallow, 9 to 30 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes	Moderate: Well drained clay loam.[2]
BlE	Blasingame clay loam, shallow, 30 to 45 percent slopes.	Slight	Severe: Slopes	Moderate: Well-drained clay loam.[2]
BmE	Blasingame very rocky clay loam, 30 to 45 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes	Moderate: Well-drained clay loam.[2]
Bn	Borden loam.	Moderate: Extremely hard sandy clay loam.	Severe: Moderately slow permeability.	Moderate: Well drained sandy clay loam.[4]
Bo	Borden loam, saline-alkali	Moderate: Extremely hard sandy clay loam.	Severe: Moderately slow permeability	High: Conductivity greater than 4.
Bt	Borden loam, moderately deep	Moderate: Extremely hard sandy clay loam	Severe: Slow permeability	Moderate: Well-drained sandy clay loam.[4]
Bu	Borden loam, moderately deep saline-alkali.	Moderate: Extremely hard sandy clay loam.	Severe: Slow permeability	High: Conductivity greater than 4.
Ca	Cajon loamy coarse sand	Severe: Loose loamy coarse sand.	Slight	Low
Cb	Cajon loamy coarse sand, saline-alkali	Severe: Loose loamy coarse sand	Slight	High: Conductivity greater than 4
Cc	Cajon coarse sandy loam.	Severe: Loose loamy coarse sand	Slight	Low
Cd	Cajon coarse sandy loam, saline-alkali	Severe: Loose loamy coarse sand.	Slight	High: Conductivity greater than 4
Ce	Cajon coarse sandy loam, moderately deep, saline-alkali.	Severe: Loose loamy coarse sand	Severe: Slow permeability	High: Conductivity greater than 4.
CfA	Calhi loamy sand, 0 to 3 percent slopes.	Severe: Loose loamy sand.	Slight	Low
CfB	Calhi loamy sand, 3 to 9 percent slopes.	Severe: Loose loamy sand.	Slight to moderate: Slopes	Low
CgA	Calhi loamy sand moderately deep, 0 to 3 percent slopes.	Severe: Loose loamy coarse sand	Severe: Slow permeability	Low
ChA	Centerville clay, 0 to 3 percent slopes.	Moderate: Very hard expanding clay	Severe: Very slow permeability	High: Well-drained clay[3]
ChC	Centerville clay, 3 to 15 percent slopes.	Moderate: Very hard expanding clay.	Severe: Very slow permeability.	High: Well-drained clay[3]
CkB	Centerville cobbly clay, 3 to 9 percent slopes.	Moderate: Very hard expanding clay	Severe: Very slow permeability	High: Well-drained clay[3]

soils for nonfarm uses—Continued

Landscaping	Recreation: Cottages, utility buildings, shelters	Recreation: Campgrounds, picnic areas	Recreation: Playgrounds, athletic fields
Very severe: Slopes; slow subsoil permeability; rockiness.	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Severe: Slow subsoil permeability; moderate soil depth.	Moderate to severe: Slopes; erosion hazard.	Severe: Slopes	Severe: Slopes.
Very severe: Slopes, slow subsoil permeability, moderate soil depth.	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes, slow subsoil permeability, moderate soil depth.	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Moderate: Moderately slow subsoil permeability	Moderate: Moderate foundation support, moderately slow subsoil permeability.	Slight	Moderate: Moderately slow subsoil permeability.
Moderate: Moderately slow subsoil permeability, saline-alkali affected.	Moderate: Moderate foundation support, moderately slow subsoil permeability	Moderate: Loam surface layer, dusty	Moderate: Moderately slow subsoil permeability, ponding.
Severe: Slow subsoil permeability	Moderate: Moderate foundation support, slow subsoil permeability.	Slight	Severe: Slow subsoil permeability.
Severe: Slow subsoil permeability, saline-alkali affected.	Moderate: Moderate foundation support, slow subsoil permeability	Moderate: Loam surface layer, dusty	Severe: Slow subsoil permeability.
Severe: Very low available water holding capacity	Severe: Poor foundation support.	Moderate: Loamy sand surface layer.	Moderate: Loamy sand surface layer.
Severe: Very low available water holding capacity.	Severe: Poor foundation support.	Moderate: Loamy sand surface layer	Moderate: Loamy sand surface layer
Severe: Very low available water holding capacity.	Severe: Poor foundation support.	Slight	Slight.
Severe: Very low available water holding capacity.	Severe: Poor foundation support.	Slight	Slight.
Moderate: Very low available water holding capacity, saline-alkali affected	Moderate to severe: Foundation support.	Slight	Severe: Slow subsoil permeability.
Severe: Very low available water holding capacity	Severe: Poor foundation support	Moderate: Loamy sand surface layer	Moderate: Loamy sand surface layer
Severe: Very low available water holding capacity	Severe: Poor foundation support.	Moderate: Loamy sand surface layer, slopes.	Moderate to severe: Slopes, loamy sand surface layer
Severe: Slow subsoil permeability, low available water holding capacity, saline-alkali affected.	Moderate to severe: Poor foundation support.	Moderate: Loamy sand surface layer	Severe: Slow subsoil permeability, loamy sand surface layer
Severe: Clay surface layer, very slow subsoil permeability.	Moderate: Moderate foundation support; clay material shrinks when dry, swells when wet.	Severe: Clay surface layer	Severe: Clay surface layer; very slow subsoil permeability.
Severe: Clay surface layer; very slow subsoil permeability.	Moderate: Moderate foundation support; clay material shrinks when dry, swells when wet.	Severe: Clay surface layer	Severe: Clay surface layer; slopes, very slow subsoil permeability
Severe: Clay surface layer, very slow subsoil permeability.	Moderate: Moderate foundation support; clay material shrinks when dry, swells when wet.	Severe: Clay surface layer	Severe: Clay surface layer, slopes, very slow subsoil permeability

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
Ck[illegible]	Centerville cobbly clay, 9 to 30 percent slopes.	Moderate: Very hard expanding clay.	Severe: Very slow permeability.	High: Well drained clay.[2]
C[illegible]	Chino sandy loam.	Moderate: Hard clay loam.	Moderate: Moderate permeability.	Low.
Cm	Chino sandy loam, saline alkali.	Moderate: Hard clay loam.	Moderate: Moderate permeability.	High: Conductivity greater than 4.
Cn	Chino fine sandy loam.	Moderate: Hard clay loam.	Moderate: Moderate permeability.	Low.
Co	Chino fine sandy loam, saline-alkali.	Moderate: Hard clay loam.	Moderate: Moderate permeability.	High: Conductivity greater than 4.
Cp	Chino fine sandy loam, moderately deep, saline-alkali.	Moderate: Hard clay loam.	Severe: Slow permeability.	High: Conductivity greater than 4.
Cr	Chino loam.	Moderate: Hard clay loam.	Moderate: Moderate permeability.	Moderate: Moderately well drained loam.[2]
Cs	Chino loam, saline alkali.	Moderate: Hard clay loam.	Moderate: Moderate permeability.	High: Conductivity greater than 4.
ClA	Chualar sandy loam, 0 to 3 percent slopes.	Moderate: Very hard sandy clay loam.	Severe: Moderately slow permeability.	High: Moderately well drained sandy clay loam.[2]
ClB	Chualar sandy loam, 3 to 9 percent slopes.	Moderate: Very hard sandy clay loam.	Severe: Moderately slow permeability.	High: Moderately well drained sandy clay loam.[2]
CuC	Cibo clay, 8 to 15 percent slopes.	Moderate: Very hard expansive clay.	Severe: Slow permeability.	High: Well drained clay.[2]
CuD	Cibo clay, 15 to 30 percent slopes.	Moderate: Very hard expansive clay.	Severe: Slopes; slow permeability.	High: Well drained clay.[2]
CuE	Cibo clay, 30 to 45 percent slopes.	Moderate: Very hard expansive clay.	Severe: Slopes; slow permeability.	High: Well drained clay.[2]
CvD	Cibo very rocky clay, 3 to 30 percent slopes.	Moderate: Very hard expansive clay.	Severe: Slow permeability, very rocky.	High: Well drained clay.[2]
CvE	Cibo very rocky clay, 30 to 45 percent slopes.	Moderate: Very hard expansive clay.	Severe: Slopes, slow permeability, very rocky.	High: Well-drained clay.[2]
CvF	Cibo very rocky clay, 45 to 70 percent slopes.	Moderate: Very hard expansive clay.	Severe: Slopes, slow permeability, very rocky.	High: Well-drained clay.[2]
CwD	Cibo extremely rocky clay, 3 to 30 percent slopes.	Moderate: Very hard expansive clay.	Severe: Slopes; extremely rocky; slow permeability.	High: Well drained clay.[2]
CwE	Cibo extremely rocky clay, 30 to 45 percent slopes.	Moderate: Very hard expansive clay.	Severe: Slopes; slow permeability.	High: Well-drained clay.[2]
CxC	Coarsegold fine sandy loam, 9 to 15 percent slopes.	Moderate: Hard light clay loam.	Severe: Slopes; moderately slow permeability.	Low to moderate.

soils for nonfarm uses—Continued

Landscaping	Recreation: Cottages, utility buildings, shelters	Recreation: Campgrounds, picnic areas	Recreation: Playgrounds, athletic fields
Severe: Clay surface layer, very slow subsoil permeability	Moderate to severe: Slopes	Severe: Slopes; clay surface layer.	Severe: Slopes; clay surface layer; very slow subsoil permeability.
Very slight	Moderate to severe: Moderate foundation support.	Moderate: Flood hazard	Moderate: Flood hazard.
Moderate: Saline-alkali affected.	Moderate to severe: Moderate foundation support.	Slight	Slight.
Very slight	Moderate to severe: Moderate foundation support.	Slight	Slight.
Slight	Moderate to severe: Moderate foundation support.	Slight to moderate: Fine sandy loam surface layer, dusty.	Slight.
Severe: Slow permeability; saline-alkali affected.	Moderate: Moderate foundation support.	Slight to moderate: Fine sandy loam surface layer; dusty.	Moderate: Moderate subsoil permeability.
Very slight	Moderate to severe: Moderate foundation support.	Slight	Slight.
	Moderate to severe: Moderate foundation support	Slight to moderate: Loam surface layer; dusty	Slight.
Moderate: Moderately slow subsoil permeability	Moderate: Moderate foundation support, moderately slow subsoil permeability.	Slight	Moderate: Moderately slow subsoil permeability.
Moderate: Moderately slow subsoil permeability.	Moderate: Moderate foundation support, moderately slow subsoil permeability	Moderate: Slopes	Severe: Slopes; moderately slow subsoil permeability.
Severe: Slow subsoil permeability, clay surface layer.	Moderate: Moderate foundation support, clay material shrinks when dry, swells when wet.	Severe: Clay surface layer	Severe: Slopes; clay surface layer, slow subsoil permeability.
Severe: Slow subsoil permeability; clay surface layer; slope.	Severe: Slopes	Severe: Slopes, clay surface layer	Severe: Slopes; clay surface layer; slow subsoil permeability.
Very severe: Slopes, slow subsoil permeability, clay surface layer.	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Severe: Slow subsoil permeability, rockiness.	Severe: Rockiness	Severe: Clay surface layer	Severe: Slopes; rockiness; clay surface layer, slow subsoil permeability.
Very severe: Slopes, slow subsoil permeability; rockiness.	Very severe: Slopes, rockiness.	Very severe: Slopes	Very severe: Slopes; rockiness, slow subsoil permeability
Very severe: Slopes; slow subsoil permeability, rockiness.	Very severe: Slopes; rockiness.	Very severe: Slopes	Very severe: Slopes; rockiness, slow subsoil permeability.
Very severe: Rockiness; slow subsoil permeability.	Severe: Rockiness	Very severe: Rockiness	Very severe: Slopes, rockiness; slow subsoil permeability
Very severe: Slopes; rockiness, slow subsoil permeability	Very severe: Slopes, rockiness	Very severe: Slopes, rockiness.	Very severe: Slope; rockiness, slow subsoil permeability.
Moderate: Slopes	Moderate: Slopes, moderate foundation support.	Severe: Slopes	Severe: Slopes

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
CxD	Coarsegold fine sandy loam, 15 to 30 percent slopes.	Moderate: Hard light clay loam.	Severe: Slopes; moderately slow permeability.	Moderate: Somewhat excessively drained light clay loam.
CxE	Coarsegold fine sandy loam, 30 to 45 percent slopes.	Moderate: Hard light clay loam.	Severe: Slopes; moderately slow permeability.	Moderate: Somewhat excessively drained light clay loam.[1]
CxF	Coarsegold fine sandy loam, 45 to 70 percent slopes.	Moderate: Hard light clay loam.	Severe: Slopes; moderately slow permeability.	Moderate: Somewhat excessively drained light clay loam.[1]
CyF	Coarsegold rocky fine sandy loam, 45 to 70 percent slopes.	Moderate: Hard light clay loam.	Severe: Slopes; moderately slow permeability.	Moderate: Somewhat excessively drained light clay loam.[1]
CzF	Colluvial land.	Severe: Loose material	Severe: Slopes	Low
CzaB	Cometa sandy loam, 3 to 9 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay[1]
CzaC	Cometa sandy loam, 9 to 15 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay[1]
CzaD	Cometa sandy loam, 15 to 30 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay[1]
CzbB	Cometa loam, 2 to 9 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay
CzcB	Cometa-San Joaquin sandy loams, 3 to 9 percent slopes.[1]			
DeA	Delhi sand, 0 to 3 percent slopes.	Severe: Soft loamy sand	Slight	Low
DeB	Delhi sand, 3 to 9 percent slopes.	Severe: Soft loamy sand	Slight to moderate: Slopes	Low
DhA	Delhi loamy sand, 0 to 3 percent slopes.	Severe: Soft loamy sand	Slight	Low
DhB	Delhi loamy sand, 3 to 9 percent slopes.	Severe: Soft loamy sand	Slight to moderate: Slopes	Low
DiA	Delhi loamy sand, moderately deep, 0 to 3 percent slopes.	Severe: Soft loamy sand	Severe: Slow permeability	Low
Dm	Dello loamy sand.	Severe: Loose loamy sand.	Severe: Water table; flooding.	Low
Dn	Dello sandy loam.	Severe: Loose loamy sand.	Severe: Water table; flooding.	Low
DpE	Delpiedra extremely stony loam, 30 to 45 percent slopes.	Moderate: Hard heavy loam.	Severe: Slopes	Low
DpF	Delpiedra extremely stony loam, 45 to 70 percent slopes.	Moderate: Hard heavy loam.	Severe: Slopes	Low
DsF	Delpiedra-Fancher extremely stony loams, 45 to 70 percent slopes.[1]			
Ec	El Peco sandy loam.	Moderate: Slightly hard sandy loam.	Severe: Very slow permeability.	High: Conductivity greater than 4.

soils for nonfarm uses—Continued

Landscaping	Recreation		
	Cottages and utility buildings	Campgrounds, picnic areas	Playgrounds, athletic fields
Severe: Slopes	Severe: Slopes	Severe: Slopes	Severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes
Severe: Slow subsoil permeability; low to very low available water holding capacity.	Moderate: Slow subsoil permeability.	Moderate: Slopes	Severe: Slopes, slow subsoil permeability
Severe: Slow subsoil permeability; low to very low available water holding capacity	Severe: Slopes	Severe: Slopes	Severe: Slopes, slow subsoil permeability
Severe: Slow subsoil permeability; low to very low available water holding capacity; slope.	Severe: Slopes	Severe: Slopes	Severe: Slopes, slow subsoil permeability.
Severe: Slow subsoil permeability; low to very low available water holding capacity	Moderate: Slow subsoil permeability	Slight to moderate: Slopes	Severe: Slow subsoil permeability
Severe: Very low available water holding capacity	Severe: Severe foundation support.	Severe: Sandy surface layer	Severe: Sandy surface layer
Severe: Very low available water holding capacity.	Severe: Severe foundation support.	Severe: Sandy surface layer	Severe: Slopes; sandy surface layer.
Severe: Very low available water holding capacity	Severe: Severe foundation support	Moderate: Loamy sand surface layer	Moderate: Loamy sand surface layer
Severe: Very low available water holding capacity	Severe: Severe foundation support	Moderate: Loamy sand surface layer, slope	Severe: Slope
Severe: Very slow subsoil permeability, low available water holding capacity.	Severe: Severe foundation support, slow subsoil permeability.	Moderate: Loamy sand surface layer.	Severe: Slow subsoil permeability, loamy sand surface layer.
Severe: Low available water holding capacity	Severe: Severe foundation support	Moderate to severe: Somewhat poor to poor drainage	Moderate to severe: Somewhat poor to poor drainage.
Severe: Low available water holding capacity	Severe: Severe foundation support.	Moderate to severe: Somewhat poor to poor drainage	Moderate to severe: Somewhat poor to poor drainage.
Very severe: Slopes, stoniness	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes, stoniness	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Severe: Saline-alkali affected	Severe: Very slow subsoil permeability	Moderate: Sandy loam surface layer, dusty	Severe: Very slow substratum permeability

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name[1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
Ed	El Peco fine sandy loam.	Moderate: Slightly hard sandy loam.	Severe: Very slow permeability.	High: Conductivity greater than 4.
Ep	El Peru loam.	Moderate: Slightly hard sandy loam.	Severe: Very slow permeability.	High: Conductivity greater than 4.
Es	Exeter sandy loam.	Moderate: Hard sandy loam.	Severe: Very slow permeability.	Low.
Et	Exeter sandy loam, shallow.	Moderate: Hard sandy loam.	Severe: Very slow permeability.	Low.
Ex	Exeter loam.	Moderate: Hard sandy loam.	Severe: Very slow permeability.	Low.
FaB	Fallbrook sandy loam, 3 to 9 percent slopes.	Moderate: Very hard clay loam.	Moderate: Moderate permeability.	Moderate: Well-drained clay loam.[2]
FaC	Fallbrook sandy loam, 9 to 15 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes.	Moderate: Well-drained clay loam.[2]
FaD	Fallbrook sandy loam, 15 to 30 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes.	Moderate: Well-drained clay loam.[2]
FaE	Fallbrook sandy loam, 30 to 45 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes.	Moderate: Well-drained clay loam.[2]
FbB	Fallbrook sandy loam, shallow, 3 to 9 percent slopes.	Moderate: Very hard clay loam.	Moderate: Moderate permeability, soil depth.	Moderate: Well-drained clay loam.
FbD	Fallbrook sandy loam, shallow, 9 to 30 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes.	Moderate: Well-drained clay loam.[2]
FcD	Fallbrook very rocky sandy loam, 3 to 30 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, rockiness.	Moderate: Well-drained clay loam.[2]
FcF	Fallbrook very rocky sandy loam, 30 to 70 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, rockiness.	Moderate: Well-drained clay loam.[2]
FdD	Fallbrook very rocky sandy loam, shallow, 3 to 30 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, rockiness.	Moderate: Well-drained clay loam.[2]
FdF	Fallbrook very rocky sandy loam, shallow, 30 to 70 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, rockiness.	Moderate: Well-drained clay loam.[2]
FeE	Fallbrook extremely rocky sandy loam, 30 to 45 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, rockiness.	Moderate: Well-drained clay loam.[2]
FhE	Fancher extremely stony loam, 30 to 45 percent slopes.	Slight.	Severe: Slopes.	High: Well-drained gravelly clay.[2]
FhF	Fancher extremely stony loam, 45 to 70 percent slopes.	Slight.	Severe: Slopes.	High: Well-drained gravelly clay.[2]
FlE	Fancher-Blasingame complex, 30 to 45 percent slopes.[3]			
FlF	Fancher-Blasingame complex, 45 to 70 percent slopes.[3]			

soils for nonfarm uses—Continued

Landscaping	Recreation		
	Cottages, utility buildings, shelters	Campgrounds, picnic areas	Playgrounds, athletic fields
Severe: Saline-alkali affected	Severe: Very slow substratum permeability.	Severe: Fine sandy loam surface layer; dusty.	Moderate: Very slow substratum permeability.
Severe: Saline-alkali affected	Severe: Very slow substratum permeability	Severe: Loam surface layer; dusty.	Moderate: Very slow substratum permeability.
Moderate: Moderate soil depth to hardpan.	Severe: Very slow substratum permeability	Slight	Moderate: Very slow substratum permeability.
Severe: Moderate soil depth to hardpan; very low available water holding capacity.	Severe: Very slow substratum permeability.	Slight	Moderate: Very slow substratum permeability
Moderate: Moderate soil depth to hardpan.	Severe: Very slow substratum permeability.	Slight	Moderate: Very slow substratum permeability.
Moderate: Moderate subsoil permeability; low available water holding capacity	Moderate: Moderate foundation support; moderate subsoil permeability; erosion hazard.	Moderate: Slopes; erosion hazard.	Severe: Slopes.
Moderate: Slopes; moderate subsoil permeability; low available water holding capacity	Moderate: Slopes; moderate foundation support; erosion hazard	Severe: Slopes	Severe: Slopes.
Severe: Slopes; moderate subsoil permeability, low available water holding capacity.	Severe: Slopes	Severe: Slopes	Severe: Slopes.
Very severe: Slopes, moderate subsoil permeability, low available water holding capacity	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Severe: Moderate soil depth; low available water holding capacity	Moderate: Moderate foundation support, erosion hazard.	Moderate: Slopes; erosion hazard.	Severe: Slopes.
Severe: Moderate soil depth, low available water holding capacity	Moderate to severe: Slope, erosion hazard.	Severe: Slopes	Severe: Slopes.
Moderate to severe: Rockiness; low available water holding capacity	Moderate to severe: Slopes; rockiness, erosion hazard.	Moderate to severe: Slopes; erosion hazard.	Severe: Slopes; rockiness; erosion hazard.
Very severe: Slopes, rockiness, low available water holding capacity	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes; rockiness, erosion hazard.
Severe: Moderate soil depth; low available water holding capacity.	Moderate to severe: Rockiness.	Moderate to severe: Slopes	Severe: Slopes; rockiness.
Very severe: Slopes; moderate soil depth, low available water holding capacity	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes, rockiness.
Very severe: Slopes; moderate soil depth, low available water holding capacity.	Very severe: Slopes; rockiness.	Very severe: Slopes, rockiness.	Very severe: Slopes, rockiness.
Very severe: Slopes	Very severe: Slopes; stoniness.	Very severe: Slopes; stoniness.	Very severe: Slopes, stoniness.
Very severe: Slopes	Very severe: Slopes; stoniness	Very severe: Slopes, stoniness	Very severe: Slopes, stoniness

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
Fm	Foster sandy loam.	Moderate: Slightly hard sandy loam.	Slight	Low
Fn	Foster loam.	Moderate: Slightly hard sandy loam.	Slight	Low
Fo	Foster loam, saline-alkali.	Moderate: Slightly hard sandy loam.	Slight	High: Conductivity greater than 4.
Fp	Foster loam, moderately deep.	Moderate: Slightly hard sandy loam.	Severe: Slow permeability	Low
Fr	Foster loam, moderately deep, saline-alkali.	Moderate: Slightly hard sandy loam.	Severe: Slow permeability	High: Conductivity greater than 4.
Fs	Fresno sandy loam.	Moderate: Very hard loam.	Severe: Very slow permeability.	High: Conductivity greater than 4.
Ft	Fresno sandy loam, shallow.	Moderate: Very hard loam.	Severe: Very slow permeability.	High: Conductivity greater than 4.
Fu	Fresno fine sandy loam.	Moderate: Very hard loam.	Severe: Very slow permeability.	High: Conductivity greater than 4.
Fv	Fresno fine sandy loam, shallow.	Moderate: Very hard loam.	Severe: Very slow permeability.	High: Conductivity greater than 4.
Fw	Fresno clay loam.	Moderate: Very hard loam.	Severe: Very slow permeability.	High: Conductivity greater than 4.
Fx	Fresno-Traver complex.[3]			
FyD	Friant fine sandy loam, 9 to 30 percent slopes.	Moderate: Slightly hard fine sandy loam.	Severe: Slopes	Low
FyE	Friant fine sandy loam, 30 to 45 percent slopes.	Moderate: Slightly hard fine sandy loam.	Severe: Slopes	Low
Ga	Grangeville sandy loam.	Severe: Soft fine sandy loam.	Slight	Moderate: Moderately well drained sandy loam.[2]
Gd	Grangeville sandy loam, saline-alkali.	Severe: Soft fine sandy loam.	Slight	High: Conductivity greater than 4.
Ge	Grangeville sandy loam, sandy substratum.	Severe: Soft fine sandy loam.	Slight	Moderate: Moderately well drained sandy loam.[2]
Gf	Grangeville fine sandy loam.	Severe: Soft fine sandy loam.	Slight	Moderate: Moderately well drained sandy loam.[2]
Gg	Grangeville fine sandy loam, saline-alkali.	Severe: Soft fine sandy loam.	Slight	High: Conductivity greater than 4.
Gh	Grangeville fine sandy loam, water table.	Severe: Soft fine sandy loam.	Severe: Water table at a depth of 2 to 4 feet.	High: Somewhat poorly drained fine sandy loam.[2]
Gk	Grangeville fine sandy loam, water table, saline-alkali.	Severe: Soft fine sandy loam.	Severe: Water table at a depth of 2 to 4 feet.	High: Conductivity greater than 4.
Gl	Grangeville fine sandy loam, gravelly substratum.	Severe: Soft fine sandy loam.	Slight	Moderate: Moderately well drained fine sandy loam.[2]

soils for nonfarm uses—Continued

Landscaping	Cottages, utility buildings, shelters	Recreation: Campgrounds, picnic areas	Recreation: Playgrounds, athletic fields
Very slight	Severe: Moderate foundation support.	Moderate: Flood hazard.	Moderate: Flood hazard.
Very slight	Severe: Moderate foundation support.	Moderate: Flood hazard.	Moderate: Flood hazard.
Moderate: Saline-alkali affected.	Severe: Moderate foundation support; flooding.	Slight to moderate: Loam surface layer; dusty.	Slight.
Severe: Slow subsoil permeability; moderate soil depth to compact layer.	Moderate: Moderate foundation support; flooding.	Moderate: Flooding.	Severe: Slow subsoil permeability.
Severe: Slow subsoil permeability; moderate soil depth to compact layer; saline-alkali affected.	Moderate: Moderate foundation support.	Slight to moderate: Loam surface layer, dusty, flooding.	Severe: Slow subsoil permeability.
Severe: Very slow subsoil permeability; saline-alkali affected.	Moderate: Very slow subsoil permeability.	Moderate: Sandy loam surface layer; dusty.	Severe: Very slow subsoil permeability.
Severe: Shallow to hardpan; saline-alkali affected.	Moderate: Very slow subsoil permeability.	Moderate: Sandy loam surface layer; dusty.	Severe: Very slow subsoil permeability.
Severe: Saline-alkali affected.	Moderate: Very slow subsoil permeability.	Severe: Fine sandy loam surface layer; dusty.	Severe: Very slow subsoil permeability.
Severe: Shallow to hardpan; saline-alkali affected.	Moderate: Very slow subsoil permeability.	Severe: Fine sandy loam surface layer; dusty.	Severe: Very slow subsoil permeability.
Severe: Shallow to hardpan; saline-alkali affected.	Severe: Ponding; very slow subsoil permeability.	Severe: Clay loam surface layer; dusty.	Severe: Very slow subsoil permeability.
Severe: Shallow soil depth; very low available water holding capacity.	Moderate to severe: Slopes.	Severe: Slopes.	Severe: Slopes.
Very severe: Slopes.	Very severe: Slopes.	Very severe: Slopes.	Very severe: Slopes.
Very slight	Severe: Severe foundation support.	Slight	Slight.
Slight	Severe: Severe foundation support.	Slight	Slight.
Slight to moderate: Moderately deep to deep to sandy substratum; low available water holding capacity.	Severe: Severe foundation support.	Slight	Slight.
Very slight	Severe: Severe foundation support.	Slight	Slight.
Slight	Severe: Severe foundation support.	Slight to moderate: Fine sandy loam surface layer, dusty.	Slight.
Moderate: Water table at a depth of 2 to 4 feet.	Severe: Severe foundation support.	Moderate: Water table; somewhat poor natural drainage.	Moderate: Water table; somewhat poor natural drainage.
Severe: Water table at a depth of 2 to 4 feet; saline-alkali affected.	Severe: Severe foundation support.	Moderate: Water table at depth of 2 to 4 feet.	Moderate: Water table at a depth of 2 to 4 feet.
Moderate: Moderately deep to deep to gravelly substratum; low available water holding capacity.	Severe: Severe foundation support.	Slight	Slight.

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
Gm	Grangeville fine sandy loam, sandy substratum.	Severe: Soft fine sandy loam.	Slight	Moderate: Moderately well drained fine sandy loam.[2]
Gn	Grangeville fine sandy loam, hard substratum.	Severe: Soft fine sandy loam.	Severe: Slow permeability	Moderate: Moderately well drained sandy loam.[2]
Go	Grangeville fine sandy loam, hard substratum, saline-alkali.	Severe: Soft fine sandy loam.	Severe: Slow permeability	High: Conductivity greater than 4.
Gp	Grangeville soils, channeled.	Severe: Soft fine sandy loam.	Severe: Subject to overflow	High: Poorly drained
GrF	Granitic rock land.	Variable: Rock less than 12 inches.	Severe: Very shallow to rock.	Low
GsA	Greenfield coarse sandy loam, 0 to 3 percent slopes.	Moderate: Hard sandy loam.	Slight	Low
GtA	Greenfield sandy loam, 0 to 3 percent slopes.	Moderate: Hard sandy loam.	Slight	Low
GtB	Greenfield sandy loam, 3 to 9 percent slopes.	Moderate: Hard sandy loam.	Moderate: Slopes	Low
GuA	Greenfield sandy loam, moderately deep, 0 to 3 percent slopes.	Moderate: Hard sandy loam.	Severe: Slow permeability	Low
Ha	Hanford coarse sandy loam.	Moderate: Slightly hard sandy loam.	Slight	Low
Hb	Hanford coarse sandy loam, hard substratum.	Moderate: Slightly hard sandy loam.	Severe: Slow permeability	Low
Hc	Hanford sandy loam.	Moderate: Slightly hard sandy loam.	Slight	Low
Hd	Hanford sandy loam, benches.	Moderate: Slightly hard sandy loam.	Slight	Low
He	Hanford sandy loam, gravelly substratum.	Moderate: Slightly hard sandy loam.	Slight	Low
Hf	Hanford sandy loam, sandy substratum.	Moderate: Slightly hard sandy loam.	Slight	Low
Hg	Hanford sandy loam, silty substratum.	Moderate: Slightly hard sandy loam.	Severe: Moderately slow permeability.	Low
Hh	Hanford sandy loam, clay loam substratum.	Moderate: Slightly hard sandy loam.	Severe: Moderately slow permeability.	Moderate: Well drained clay loam.[2]
Hk	Hanford sandy loam, hard substratum.	Moderate: Slightly hard sandy loam.	Severe: Slow permeability	Moderate: Well-drained, hard sediment.

soils for nonfarm uses—Continued

Landscaping	Recreation: Cottages, utility buildings, shelters	Recreation: Campgrounds, picnic areas	Recreation: Playgrounds, athletic fields
Moderate: Moderately deep to deep to sandy substratum; low available water holding capacity.	Severe: Severe foundation support.	Slight	Slight.
Severe: Slow substratum permeability; moderately deep to deep to hard substratum; low available water holding capacity.	Moderate to severe: Severe foundation support.	Slight	Severe: Slow substratum permeability.
Severe: Slow substratum permeability; moderately deep to deep to hard substratum; saline-alkali affected.	Moderate to severe: Severe foundation support.	Slight to moderate: Fine sandy loam surface layer.	Severe: Slow substratum permeability.
Moderate: Flooding	Severe: Severe foundation support.	Moderate: Channeled surface relief; flood hazard.	Severe: Channeled surface relief.
Very severe: Rockiness	Very severe: Rockiness	Very severe: Rockiness	Very severe: Rockiness.
Very slight	Moderate to severe: Moderate foundation support.	Slight	Slight.
Very slight	Moderate to severe: Moderate foundation support.	Slight	Slight.
Slight to moderate: Slopes	Moderate to severe: Moderate foundation support.	Moderate: Slopes	Severe: Slopes.
Severe: Slow substratum permeability; moderately deep to compact substratum; moderate available water holding capacity.	Moderate: Moderate foundation support.	Slight	Severe: Slow subsoil permeability.
Slight	Severe: Moderate foundation support.	Slight	Moderate: Coarse sandy loam surface layer.
Severe: Slow substratum permeability; moderately deep to compact substratum; low available water holding capacity.	Moderate: Moderate foundation support.	Slight	Severe: Slow substratum permeability.
Very slight	Moderate to severe: Moderate foundation support.	Slight	Slight.
Slight	Moderate to severe: Moderate foundation support.	Slight to moderate: Slopes; erosion hazard.	Moderate to severe: Slopes.
Moderate: Moderately deep to gravelly substratum; low available water holding capacity.	Moderate to severe: Moderate foundation support.	Slight	Slight.
Moderate: Moderately deep to sandy substratum; low available water holding capacity.	Moderate to severe: Moderate foundation support.	Slight	Slight.
Moderate: Moderately slow substratum permeability.	Moderate to severe: Moderate foundation support.	Slight	Moderate: Moderately slow substratum permeability.
Moderate: Moderately slow substratum permeability.	Moderate: Moderate foundation support.	Slight	Moderate: Moderately slow substratum permeability.
Severe: Slow substratum permeability; moderately deep to deep to compact substratum; moderate available water holding capacity.	Moderate: Moderate foundation support.	Slight	Severe: Slow substratum permeability.

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TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
Hl	Hanford gravelly sandy loam.	Moderate: Slightly hard gravelly sandy loam.	Slight	Low
Hm	Hanford fine sandy loam	Moderate: Slightly hard fine sandy loam.	Slight	Low
Hn	Hanford fine sandy loam, gravelly substratum.	Moderate: Slightly hard fine sandy loam	Slight	Low
Ho	Hanford fine sandy loam, silty substratum.	Moderate. Slightly hard fine sandy loam.	Severe: Moderately slow permeability.	Low
Hp	Hanford fine sandy loam, clay loam substratum.	Moderate: Slightly hard gravelly sandy loam	Severe Moderately slow permeability	Moderate: Well-drained clay loam.[2]
Hr	Hanford fine sandy loam, hard substratum.	Moderate: Hard fine sandy loam.	Severe: Slow permeability	Low
Hsa	Hesperia coarse sandy loam.	Moderate: Hard coarse sandy loam	Slight	Low
Hsc	Hesperia coarse sandy loam, saline-alkal.	Moderate: Hard coarse sandy loam.	Slight	High. Conductivity greater than 4.
Hsd	Hesperia sandy loam.	Moderate: Hard sandy loam.	Slight	Low
Hse	Hesperia sandy loam, saline-alkali.	Moderate: Hard sandy loam.	Slight	High: Conductivity greater than 4.
Hsm	Hesperia sandy loam, moderately deep.	Moderate: Hard sandy loam.	Severe. Moderately slow permeability.	Low
Hsn	Hesperia sandy loam, moderately deep, saline-alkali.	Moderate: Hard sandy loam.	Severe: Moderately slow permeability	High Conductivity greater than 4.
Hso	Hesperia sandy loam, shallow.	Moderate: Hard sandy loam.	Severe: Moderately slow permeability.	Low
Hsp	Hesperia sandy loam, shallow, saline alkali.	Moderate: Hard fine sandy loam.	Severe Moderately slow permeability.	High: Conductivity greater than 4
Hsr	Hesperia fine sandy loam.	Moderate: Hard fine sandy loam.	Slight	Low
Hss	Hesperia fine sandy loam, saline-alkali	Moderate: Hard fine sandy loam.	Slight	High: Conductivity greater than 4.
Hst	Hesperia fine sandy loam, moderately deep.	Moderate: Hard fine sandy loam.	Severe: Moderately slow permeability	Low
Hsv	Hesperia fine sandy loam, moderately deep, saline alkali.	Moderate: Hard fine sandy loam	Severe: Moderately slow permeability.	High. Conductivity greater than 4
HtC	Hideaway extremely stony loam, 2 to 15 percent slopes.	Variable	Severe: Very shallow soil depth; stoniness	Moderate: Very shallow soil depth.
Hu	Hildreth clay	Slight	Severe: Very slow permeability.	High Somewhat poorly drained clay
HvF	Holland coarse sandy loam, 15 to 45 percent slopes.	Moderate Very hard sandy clay loam.	Severe: Moderately slow permeability; slopes	Moderate: Well-drained sandy clay loam

soils for nonfarm uses—Continued

Landscaping	Cottages, utility buildings, shelters	Recreation	
		Campgrounds, picnic areas	Playgrounds, athletic fields
Slight	Severe: Moderate foundation support.	Moderate: Gravelly sandy loam surface layer.	Moderate: Gravelly sandy loam surface layer.
Very slight	Moderate to severe: Moderate foundation support.	Slight	Slight.
Moderate: Moderately deep to substratum; low available water holding capacity.	Moderate to severe: Moderate foundation support.	Slight	Slight.
Moderate: Moderately slow substratum permeability.	Moderate to severe: Moderate foundation support.	Slight	Moderate: Moderately slow substratum permeability.
Moderate: Moderately slow substratum permeability.	Moderate to severe: Moderate foundation support.	Slight	Moderate: Moderately slow substratum permeability.
Severe: Slow substratum permeability; moderately deep to deep to compact substratum; moderate available water holding capacity.	Moderate: Moderate foundation support.	Slight	Severe: Slow substratum permeability.
Slight	Severe: Moderate foundation support.	Slight	Moderate: Coarse sandy loam surface layer.
Slight	Severe: Moderate foundation support.	Slight	Moderate: Coarse sandy loam surface layer.
Very slight	Moderate to severe: Moderate foundation support.	Slight	Slight.
Slight	Moderate to severe: Moderate foundation support.	Slight	Slight
Moderate: Moderately slow substratum permeability.	Moderate to severe: Moderate foundation support.	Slight	Moderate: Moderately slow substratum permeability.
Moderate: Moderately slow substratum permeability.	Moderate to severe: Moderate foundation support.	Slight	Moderate: Moderately slow substratum permeability.
Moderate: Low available water holding capacity; moderately slow substratum permeability.	Moderate: Moderate foundation support.	Slight	Slight.
Moderate: Low available water holding capacity; saline-alkali affected.	Moderate: Moderate foundation support.	Slight	Slight
Very slight	Moderate to severe: Moderate foundation support.	Slight	Slight.
Slight	Moderate to severe: Moderate foundation support.	Slight to moderate: Fine sandy loam surface layer, dusty.	Slight.
Moderate: Moderately slow substratum permeability.	Moderate to severe: Moderate foundation support.	Slight	Moderate: Moderately slow substratum permeability.
Moderate: Moderately slow substratum permeability.	Moderate to severe: Moderate foundation support.	Slight to moderate: Fine sandy loam surface layer, dusty.	Moderate: Moderately slow substratum permeability.
Very severe: Very shallow soil depth.	Moderate: Stoniness	Moderate: Stoniness	Severe: Slopes, stoniness.
Severe: Clay texture; somewhat poor drainage; very slow subsoil permeability.	Severe: Very slow permeability; seasonal ponding.	Severe: Clay surface layer; somewhat poor drainage.	Severe: Very slow permeability; seasonal ponding; clay surface layer.
Severe to very severe: Slopes	Severe to very severe: Slopes	Severe to very severe: Slopes.	Severe to very severe: Slopes.

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
HwA	Honcut fine sandy loam, 0 to 3 percent slopes.	Moderate: Hard fine sandy loam.	Slight	Low
HwB	Honcut fine sandy loam, 3 to 9 percent slopes.	Moderate: Hard fine sandy loam.	Moderate: Slopes	Low
HyA	Honcut fine sandy loam, gravelly substratum, 0 to 3 percent slopes.	Moderate: Hard fine sandy loam.	Slight	Low
HzA	Honcut fine sandy loam, hard substratum, 0 to 3 percent slopes.	Moderate: Hard fine sandy loam.	Severe: Slow permeability	Low
KeC	Keefers loam, 3 to 15 percent slopes.	Slight	Severe: Slow permeability	High: Well-drained cobbly clay.[2]
KfD	Keefers cobbly loam, 3 to 30 percent slopes.	Slight	Severe: Slow permeability	High: Well-drained cobbly clay.[2]
KmC	Keyes cobbly clay loam, 3 to 15 percent slopes.	Slight	Severe: Very slow permeability	High: Well-drained cobbly clay.[2]
LbB	Los Robles sandy loam, 2 to 9 percent slopes.	Moderate: Hard light clay loam.	Slight to moderate: Slopes	Moderate: Well-drained light clay loam.[2]
LgB	Los Robles sandy loam, gravelly substratum, 2 to 9 percent slopes.	Moderate: Hard light clay loam.	Slight to moderate: Slopes	Moderate: Well-drained light clay loam.[2]
LmA	Los Robles loam, 0 to 3 percent slopes.	Moderate: Hard light clay loam.	Slight	Moderate: Well-drained light clay loam.[2]
LmB	Los Robles loam, 3 to 9 percent slopes.	Moderate: Hard light clay loam.	Slight to moderate: Slopes	Moderate: Well-drained light clay loam.[2]
LhB	Los Robles loam, hard substratum, 2 to 9 percent slopes.	Moderate: Hard light clay loam.	Severe: Slow permeability	Moderate: Well-drained light clay loam.[2]
LoA	Los Robles clay loam, 0 to 3 percent slopes.	Moderate: Hard light clay loam.	Severe: Moderately slow permeability	Moderate: Well-drained light clay loam.[2]
Ma	Madera sandy loam.	Moderate: Hard loam	Severe: Very slow permeability	High: Well-drained clay.[2]
Mc	Madera loam.	Slight: Hard loam	Severe: Very slow permeability	High: Well-drained clay.[2]
Md	Madera loam, saline-alkali.	Moderate: Hard loam	Severe: Very slow permeability	High: Well-drained clay
Me	Madera clay loam.	Moderate: Hard clay loam.	Severe: Very slow permeability	High: Well-drained clay.[2]
Mf	Merced clay loam.	Moderate: Very hard expanding clay.	Severe: Slow permeability	High: Moderately well drained clay.[2]
Mg	Merced clay loam, slightly saline.	Moderate: Very hard expanding clay.	Severe: Slow permeability	High: Moderately well drained clay.[2]

soils for nonfarm uses—Continued

Landscaping	Recreation: Cottages, utility buildings, shelters	Recreation: Campgrounds, picnic areas	Recreation: Playgrounds, athletic fields
Very slight	Moderate to severe: Moderate foundation support.	Slight	Slight.
Slight to moderate: Slopes	Moderate to severe: Moderate foundation support.	Moderate: Slopes	Severe: Slopes.
Moderate: Moderately deep to deep to gravelly substratum; very low available water holding capacity.	Moderate to severe: Moderate foundation support.	Slight	Slight.
Severe: Slow substratum permeability; moderately deep to compact substratum; low available water holding capacity.	Moderate: Moderate foundation support.	Slight	Severe: Slow substratum permeability.
Severe: Slow subsoil permeability.	Moderate: Slow subsoil permeability.	Moderate to severe: Slopes	Severe: Slopes, slow subsoil permeability.
Severe: Slow subsoil permeability, cobbly.	Moderate to severe: Slopes; slow subsoil permeability.	Moderate to severe: Slopes; cobbly.	Severe: Slopes, cobbly, slow subsoil permeability.
Very severe: Very slow subsoil permeability.	Moderate: Very slow subsoil permeability.	Moderate to severe: Slopes; cobbly.	Severe: Slopes, very slow subsoil permeability.
Slight to moderate: Slopes	Moderate to severe: Moderate foundation support.	Moderate: Slopes	Moderate to severe: Slopes.
Moderate: Moderately deep to gravelly substratum; low available water holding capacity.	Moderate to severe: Moderate foundation support.	Moderate: Slopes	Moderate to severe: Slopes.
Very slight	Moderate to severe: Moderate foundation support.	Slight	Slight.
Slight to moderate: Slopes	Moderate to severe: Moderate foundation support.	Moderate: Slopes	Severe: Slopes.
Severe: Slow subsoil permeability; moderately deep to deep to compact substratum; low to moderate water holding capacity.	Moderate: Moderate foundation support.	Slight to moderate: Slopes	Severe: Slow subsoil permeability; slopes.
Moderate: Moderately slow subsoil permeability.	Moderate: Moderate foundation support.	Slight	Moderate: Moderately slow subsoil permeability.
Severe: Very slow subsoil permeability.	Moderate: Very slow subsoil permeability.	Slight	Severe: Very slow subsoil permeability.
Severe: Very slow subsoil permeability.	Moderate: Very slow subsoil permeability.	Slight	Severe: Very slow subsoil permeability.
Severe: Very slow subsoil permeability; saline-alkali affected.	Moderate: Very slow subsoil permeability.	Severe: Loam surface layer; dusty.	Severe: Very slow subsoil permeability.
Severe: Very slow subsoil permeability.	Moderate: Very slow subsoil permeability.	Moderate: Clay loam surface layer.	Severe: Very slow subsoil permeability.
Severe: Slow subsoil permeability.	Moderate: Moderate foundation support; clay material shrinks when dry, swells when wet.	Moderate: Clay loam surface layer.	Severe: Slow subsoil permeability.
Severe: Slow subsoil permeability.[1]	Moderate: Moderate foundation support; clay material shrinks when dry, swells when wet.	Moderate: Clay loam surface layer.	Severe: Slow subsoil permeability.

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
Mh	Merced clay	Moderate: Very hard expanding clay.	Severe: Slow permeability	High: Moderately well drained clay.[2]
Mk	Merced clay, slightly saline	Moderate: Very hard expanding clay	Severe: Slow permeability	High: Moderately well drained clay.
Ml	Merced clay, moderately saline.	Moderate: Very hard expanding clay	Severe: Slow permeability	High: Moderately well drained clay.[2]
Mm	Merced clay, saline-alkali.	Moderate: Very hard expanding clay.	Severe: Very slow permeability.	High: Moderately well drained clay.[2]
MnD	Millerton fine sandy loam, 9 to 30 percent slopes.	Moderate: Hard fine sandy loam	Severe: Slopes	Low
MnE	Millerton fine sandy loam, 30 to 45 percent slopes.	Moderate: Hard fine sandy loam.	Severe: Slopes	Low
MnF	Millerton fine sandy loam, 45 to 70 percent slopes.	Moderate: Hard fine sandy loam.	Severe: Slopes	Low
MnF2	Millerton fine sandy loam, 45 to 70 percent slopes, eroded.	Moderate: Hard fine sandy loam.	Severe: Slopes	Low
MoD	Millerton rocky fine sandy loam, 3 to 30 percent slopes.	Moderate: Hard fine sandy loam.	Severe: Slopes	Low
MoE	Millerton very rocky fine sandy loam, 30 to 45 percent slopes.	Moderate: Hard fine sandy loam.	Severe: Slopes	Low
MoF	Millerton very rocky fine sandy loam, 45 to 70 percent slopes.	Moderate: Hard fine sandy loam.	Severe: Slopes	Low
MpC	Montpellier coarse sandy loam, 9 to 15 percent slopes	Moderate: Hard coarse sandy loam.	Severe: Slopes, slow permeability.	Moderate: Well-drained coarse sandy clay loam.[2]
MpD	Montpellier coarse sandy loam, 15 to 30 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes, slow permeability	Moderate: Well drained coarse sandy clay loam.[2]
MrB	Mt. Olive clay, 3 to 9 percent slopes.	Moderate: Slightly hard expanding clay	Severe: Slow permeability	High: Well-drained clay.[2]
MrC	Mt. Olive clay, 9 to 15 percent slopes.	Moderate: Slightly hard expanding clay	Severe: Slow permeability	High: Well-drained clay.[2]
No	Nord loam	Severe: Soft loam	Severe: Moderately slow permeability	Moderate: Moderately well drained loam.[2]
Ns	Nord loam, saline-alkali.	Severe: Soft loam	Severe: Moderately slow permeability	Moderate to high: Conductivity greater than 4.
Pa	Pachappa loam.	Moderate: Hard light clay loam.	Moderate: Moderate permeability.	Moderate: Well drained light clay loam.[2]
Pc	Pachappa loam, saline-alkali	Moderate: Hard light clay loam.	Moderate: Moderate permeability	High: Conductivity greater than 4.
Pd	Pachappa loam, moderately deep	Moderate: Hard light clay loam.	Severe: Moderately slow permeability	Moderate: Well drained light clay loam.[2]

soils for nonfarm uses—Continued

Landscaping	Recreation		
	Cottages, utility buildings, shelters	Campgrounds, picnic areas	Playgrounds, athletic fields
Severe: Clay texture, slow subsoil permeability.	Moderate: Moderate foundation support, clay material shrinks when dry, swells when wet.	Severe: Clay surface layer	Severe: Clay surface layer, slow subsoil permeability.
Severe: Clay surface layer, slow subsoil permeability.	Moderate: Moderate foundation support, clay material shrinks when dry, swells when wet.	Severe: Clay surface layer	Severe: Clay surface layer, slow subsoil permeability.
Very severe: Clay surface layer, slow subsoil permeability.	Moderate: Moderate foundation support, clay material shrinks when dry, swells when wet.	Severe: Clay surface layer	Severe: Clay surface layer, slow subsoil permeability.
Very severe: Clay surface layer; very slow subsoil permeability; saline-alkali affected.	Severe: Seasonal flooding; very slow subsoil permeability.	Severe: Seasonal flooding	Severe: Seasonal flooding, very slow subsoil permeability.
Severe: Shallow soil depth	Moderate to severe: Slopes	Severe: Slopes	Severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Severe: Shallow soil depth	Moderate to severe: Rockiness; erosion hazard.	Moderate to severe: Slopes, erosion hazard.	Moderate to severe: Slopes; rockiness; erosion hazard.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Moderate: Slopes, slow subsoil permeability.	Moderate to severe: Slow subsoil permeability; erosion hazard.	Severe: Slopes	Severe: Slow subsoil permeability; slopes.
Severe: Slopes; slow subsoil permeability.	Severe: Slopes, slow subsoil permeability.	Severe: Slopes	Severe: Slow subsoil permeability; slopes.
Severe: Slow subsoil permeability.	Moderate: Moderate foundation support, slow subsoil permeability.	Moderate: Slopes	Severe: Slow subsoil permeability; slopes.
Severe: Slow subsoil permeability.	Moderate: Moderate foundation support, slopes; slow subsoil.	Severe: Slopes	Severe: Slow subsoil permeability; slopes.
Moderate: Moderately slow subsoil permeability.	Severe: Poor foundation support.	Severe: Loam surface layer, dusty.	Moderate: Moderately slow subsoil permeability.
Moderate: Saline-alkali affected, moderately slow permeability.	Severe: Poor foundation support.	Severe: Loam surface layer, dusty.	Moderate: Moderately slow subsoil permeability.
Very slight	Moderate to severe: Moderate foundation support.	Slight	Slight.
Slight	Moderate to severe: Moderate foundation support.	Moderate: Loam surface layer, dusty.	Slight.
Moderate: Moderately deep to silty substratum, moderately slow subsoil permeability.	Moderate: Moderate foundation support.	Slight	Moderate: Moderately slow subsoil permeability.

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
Pe	Pachappa loam, moderately deep, saline alkali.	Moderate: Hard light clay loam.	Severe: Moderately slow permeability.	High: Conductivity greater than 4.
PfB	Piper sandy loam, 0 to 9 percent slopes.	Moderate: Very hard sandy loam.	Slight to moderate: Slopes	High: Conductivity greater than 4.
PgB	Piper fine sandy loam, 0 to 9 percent slopes.	Moderate: Very hard sandy loam.	Slight to moderate: Moderate permeability.	High: Conductivity greater than 4.
PhB	Piper-Rossi complex, 0 to 9 percent slopes.[2]			
Pk	Pits.[2]			
Pl	Playas.	Slight	Severe: Very slow permeability	High: Conductivity greater than 4.
PmB	Pollasky sandy loam, 2 to 9 percent slopes.	Moderate: Hard sandy loam.	Slight to moderate: Slopes	Low
PmC	Pollasky sandy loam, 9 to 15 percent slopes.	Moderate: Hard sandy loam.	Severe: Slopes	Low
PmD	Pollasky sandy loam, 15 to 30 percent slopes.	Moderate: Hard sandy loam.	Severe: Slopes	Low
PnB	Pollasky fine sandy loam, 2 to 9 percent slopes.	Moderate: Hard sandy loam.	Slight to moderate: Slopes	Low
PnC	Pollasky fine sandy loam, 9 to 15 percent slopes.	Moderate: Hard sandy loam.	Severe: Slopes	Low
PoC	Pollasky-Montpellier complex, 9 to 15 percent slopes.[2]			
PoD	Pollasky-Montpellier complex, 15 to 30 percent slopes.[2]			
PpC	Pollasky-Rocklin sandy loams, 3 to 15 percent slopes.[2]			
Pr	Pond sandy loam.	Moderate: Very hard sandy clay loam.	Severe: Moderately slow permeability.	High: Conductivity greater than 4.
Ps	Pond sandy loam, moderately deep.	Moderate: Very hard sandy clay loam.	Severe: Slow permeability	High: Conductivity greater than 4.
Pt	Pond fine sandy loam.	Moderate: Very hard sandy clay loam	Severe: Moderately slow permeability.	High: Conductivity greater than 4.
Pu	Pond fine sandy loam, moderately deep.	Moderate: Very hard sandy clay loam.	Severe: Slow permeability	High: Conductivity greater than 4.
Pv	Pond loam.	Moderate: Very hard sandy clay loam.	Severe: Moderately slow permeability.	High: Conductivity greater than 4.
Pw	Pond loam, moderately deep.	Moderate: Very hard sandy clay loam.	Severe: Slow permeability	High: Conductivity greater than 4.
PxA	Porterville clay, 0 to 3 percent slopes.	Moderate: Very hard expanding clay.	Severe: Slow permeability	High: Well-drained clay[3]

soils for nonfarm uses—Continued

Landscaping	Recreation: Cottages, utility buildings, shelters	Recreation: Campgrounds, picnic areas	Recreation: Playgrounds, athletic fields
Moderate: Saline-alkali affected; moderately slow subsoil permeability	Moderate: Moderate foundation support.	Moderate: Loam surface layer, dusty	Moderate: Moderately slow subsoil permeability.
Slight to moderate: Saline-alkali affected.	Moderate: Moderate foundation support.	Slight	Slight to moderate: Slopes.
Moderate: Saline-alkali affected.	Moderate: Moderate foundation support.	Slight	Slight to moderate: Slopes.
Very severe: Saline-alkali; very slow permeability	Severe: Seasonal ponding; very poor drainage.	Severe: Seasonal ponding; very poor drainage.	Severe: Seasonal ponding; very poor drainage.
Moderate: Low available water holding capacity	Moderate: Moderate foundation support.	Slight to moderate: Slopes	Moderate to severe: Slopes.
Moderate: Slopes; low available water holding capacity	Moderate: Slopes; moderate foundation support.	Severe: Slopes	Severe: Slopes.
Severe: Slopes	Severe: Slopes	Severe: Slopes, erosion hazard.	Severe: Slopes; erosion hazard.
Slight to moderate: Slopes, low available water holding capacity.	Moderate: Moderate foundation support.	Slight to moderate: Slopes	Moderate to severe: Slopes.
Moderate: Slopes	Moderate: Moderate foundation support.	Severe: Slopes	Severe: Slopes.
Severe: Moderately slow subsoil permeability; saline-alkali affected.	Moderate: Moderate foundation support, moderately slow subsoil permeability.	Moderate: Sandy loam surface layer, dusty	Moderate: Moderately slow subsoil permeability
Severe: Slow subsoil permeability; saline-alkali affected	Moderate: Moderate foundation support; moderately slow subsoil permeability	Moderate: Sandy loam surface layer, dusty	Severe: Slow subsoil permeability.
Severe: Moderately slow subsoil permeability, saline-alkali affected.	Moderate: Moderate foundation support, moderately slow subsoil permeability.	Severe: Fine sandy loam surface layer; dusty	Moderate: Moderately slow subsoil permeability.
Severe: Slow subsoil permeability; saline-alkali affected	Moderate: Moderate foundation support, moderately slow subsoil permeability.	Severe: Fine sandy loam surface layer; dusty	Severe: Slow subsoil permeability
Severe: Moderately slow subsoil permeability; saline-alkali affected.	Moderate: Moderate foundation support; moderately slow subsoil permeability	Severe: Loam surface layer; dusty	Moderate: Moderately slow subsoil permeability
Severe: Slow subsoil permeability; saline-alkali affected.	Moderate: Moderate foundation support, moderately slow subsoil permeability.	Severe: Loam surface layer, dusty	Severe: Slow subsoil permeability
Severe: Clay surface layer, slow subsoil permeability	Moderate: Moderate foundation support, clay material shrinks when dry, swells when wet.	Severe: Clay surface layer	Severe: Clay surface layer; slow subsoil permeability.

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name[1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
PxC	Porterville clay, 3 to 15 percent slopes.	Moderate: Very hard expanding clay.	Severe: Slow permeability	High: Well-drained clay[3]
PyC	Porterville cobbly clay, 3 to 15 percent slopes.	Moderate: Very hard expanding clay.	Severe: Slow permeability	High: Well-drained clay[3]
PzD	Porterville very cobbly clay, 0 to 30 percent slopes.	Moderate: Very hard expanding clay.	Severe: Slow permeability	High: Well-drained clay[3]
PzaB	Positas gravelly loam, 3, to 9 percent slopes	Slight	Severe: Very slow permeability.	High: Well-drained clay[3]
PzaD	Positas gravelly loam, 9 to 30 percent slopes.	Slight	Severe: Slopes, very slow permeability.	High: Well-drained clay[3]
PzaE	Positas gravelly loam, 30 to 45 percent slopes.	Slight	Severe: Slopes, very slow permeability	High: Well drained clay[3]
Ra	Ramona sandy loam.	Moderate: Very hard sandy loam.	Severe: Moderately slow permeability.	Moderate: Well-drained sandy clay loam.[3]
Rb	Ramona sandy loam, hard substratum.	Moderate: Very hard sandy loam.	Severe: Slow permeability	Moderate: Well-drained sandy clay loam[3]
Rc	Ramona loam.	Moderate: Very hard sandy loam.	Severe: Moderately slow permeability.	Moderate: Well drained sandy clay loam.[3]
Rd	Ramona loam, gravelly substratum.	Moderate: Very hard sandy loam.	Severe: Moderately slow permeability	Moderate: Well-drained sandy clay loam.[3]
Re	Ramona loam, hard substratum.	Moderate: Very hard sandy loam.	Severe: Slow permeability	Moderate: Well drained sandy clay loam.[3]
RfC	Redding gravelly loam, 3 to 15 percent slopes.	Slight	Severe: Very slow permeability	High: Well-drained clay[3]
RgB	Redding gravelly loam, shallow, 0 to 9 percent slopes.	Slight	Severe: Very slow permeability	High: Well drained clay[3]
Rh	Riverwash.	Severe: Loose sands and gravels.	Severe: Subject to frequent overflow.	High: Very poorly drained[3]
RkB	Rocklin sandy loam, 3 to 9 percent slopes.	Moderate: Hard sandy clay loam	Severe: Very slow permeability.	High: Well-drained sandy clay loam.[3]
RlD	Rocklin sandy loam pumiceous variant, 3 to 30 percent slopes.	Moderate: Very hard sandy clay loam.	Severe: Very slow permeability	Moderate: Well-drained sandy clay loam.[3]
Rr	Rossi fine sandy loam	Moderate: Very hard clay loam	Severe: Slow permeability	High: Conductivity greater than 4
Rs	Rossi clay loam.	Moderate: Very hard clay loam.	Severe: Slow permeability	High: Conductivity greater than 4.
Sa	Sandy alluvial land.	Severe: Loose stratified sand.	Severe: Subject to overflow	Moderate: Somewhat poorly drained.[3]

soils for nonfarm uses—Continued

Landscaping	Recreation: Cottages, utility buildings, shelters	Recreation: Campgrounds, picnic areas	Recreation: Playgrounds athletic fields
Severe: Clay surface layer slow subsoil permeability	Moderate: Moderate foundation support clay material shrinks when dry, swells when wet.	Severe: Clay surface layer	Severe: Slopes; clay surface layer, slow subsoil permeability
Severe: Clay surface layer, slow subsoil permeability.	Moderate: Moderate foundation support; clay material shrinks when dry, swells when wet.	Severe: Clay surface layer	Severe: Slopes; clay surface layer; slow subsoil permeability.
Very severe: Clay surface layer, slow subsoil permeability	Severe: Clay surface layer, cobbly, clay shrinks when dry, swells when wet.	Moderate: Slopes; clay surface layer, cobbly.	Severe: Clay surface layer, cobbly, slow subsoil permeability
Severe: Very slow subsoil permeability.	Moderate: Very slow subsoil permeability.	Moderate: Slopes; gravelly loam surface layer.	Severe: Slopes; very slow subsoil permeability.
Severe: Very slow subsoil permeability.	Severe: Slopes; very slow subsoil permeability.	Severe: Slopes	Severe: Slopes very slow subsoil permeability.
Very severe: Slopes	Very severe: Slopes very slow subsoil permeability	Very severe: Slopes	Very severe: Slopes; very slow subsoil permeability.
Moderate: Moderately slow subsoil permeability.	Moderate: Moderate foundation support.	Slight	Moderate. Moderately slow subsoil permeability.
Severe: Slow subsoil permeability; low to moderate available water holding capacity	Moderate: Moderate foundation support.	Slight	Severe: Slow subsoil permeability.
Moderate: Moderately slow subsoil permeability.	Moderate: Moderate foundation support	Slight	Moderate: Moderately slow subsoil permeability
Moderate: Gravelly substratum at a depth of 2 to 4 feet, low available water holding capacity	Moderate: Moderate foundation support.	Slight	Moderate: Moderately slow subsoil permeability.
Severe: Slow subsoil permeability; low to moderate available water holding capacity.	Moderate: Moderate foundation support.	Slight	Severe: Slow subsoil permeability.
Severe: Very slow subsoil permeability	Severe: Very slow subsoil permeability	Moderate to severe: Slopes	Severe: Slopes; very slow subsoil permeability.
Severe: Very slow subsoil permeability, shallow to hardpan.	Severe: Very slow subsoil permeability	Moderate. Gravelly loam surface layer; hummocks.	Severe. Slopes, very slow subsoil permeability.
Very severe: Flood hazard	Severe: Flood hazard	Severe: Flood hazard	Severe: Flood hazard.
Severe: Very slow subsoil permeability, moderate depth to hardpan.	Severe: Very slow subsoil permeability.	Moderate. Slopes	Severe: Very slow subsoil permeability; slopes.
Severe: Very low available water holding capacity	Severe: Very slow subsoil permeability; slopes, erosion hazard	Moderate to severe Slopes	Severe: Very slow subsoil permeability, slopes.
Severe: Slow subsoil permeability; saline-alkali affected.	Moderate: Moderate foundation support, slow subsoil permeability.	Slight to severe: Flood hazard.	Severe: Slow subsoil permeability.
Severe: Slow subsoil permeability; saline-alkali affected.	Moderate: Moderate foundation support; slow subsoil permeability	Moderate: Clay loam surface layer	Severe: Slow subsoil permeability.
Very severe: Flood hazard	Very severe: Flood hazard	Very severe: Flood hazard	Very severe: Flood hazard.

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
Sb	Sandy alluvial land, leveled.[3]			
ScA	San Joaquin sandy loam, 0 to 3 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay.[4]
SdA	San Joaquin sandy loam, shallow, 0 to 3 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay.[4]
SdB	San Joaquin sandy loam, shallow, 3 to 9 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay.[4]
SeA	San Joaquin loam, 0 to 3 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay.[4]
SfA	San Joaquin loam, gravelly substratum, 0 to 3 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay.[4]
SgA	San Joaquin loam, shallow, 0 to 3 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay.[4]
SgB	San Joaquin loam, shallow, 3 to 9 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay.[4]
ShB	San Joaquin-Alamo complex, 3 to 9 percent slopes.[3]			
SkB	Sesame sandy loam, 3 to 9 percent slopes.	Moderate: Very hard sandy clay loam.	Severe: Moderately slow permeability.	Moderate: Well drained sandy clay loam.[4]
SkC	Sesame sandy loam, 9 to 15 percent slopes.	Moderate: Very hard sandy clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well drained sandy clay loam.[4]
SkD	Sesame sandy loam, 15 to 30 percent slopes.	Moderate: Very hard sandy clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well-drained sandy clay loam.[4]
SlB	Sesame loam, 3 to 9 percent slopes.	Moderate: Very hard sandy clay loam.	Severe: Moderately slow permeability.	Moderate: Well drained sandy clay loam.[4]
SlC	Sesame loam, 9 to 15 percent slopes.	Moderate: Very hard sandy clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well-drained sandy clay loam.[4]
SmE	Shaver coarse sandy loam, 15 to 45 percent slopes.	Severe: Soft coarse sandy loam.	Severe: Slopes.	Low.
SnC	Sierra sandy loam, 9 to 15 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well-drained clay loam.[4]
SnD	Sierra sandy loam, 15 to 30 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well-drained clay loam.[4]

soils for nonfarm uses—Continued

Landscaping	Recreation: Cottages, utility buildings, shelters	Recreation: Campgrounds, picnic areas	Recreation: Playgrounds, athletic fields
Severe: Very slow subsoil permeability; hardpan at a depth of 24 to 48 inches; very low to low available water holding capacity.	Severe: Very slow subsoil permeability.	Slight	Severe: Very slow subsoil permeability
Severe: Very slow subsoil permeability; hardpan at a depth of 12 to 24 inches; very low available water holding capacity.	Severe: Very slow subsoil permeability.	Slight	Severe: Very slow subsoil permeability.
Severe: Very slow subsoil permeability; hardpan at a depth of 12 to 24 inches; very low available water holding capacity.	Severe: Very slow subsoil permeability.	Moderate: Slopes	Severe: Slopes; very slow subsoil permeability
Severe: Very slow subsoil permeability; hardpan at a depth of 24 to 48 inches.	Severe: Very slow subsoil permeability	Moderate: Loam surface layer, dusty	Severe: Very slow subsoil permeability.
Severe: Very slow subsoil permeability; gravelly substratum at a depth of 24 to 48 inches.	Severe: Very slow subsoil permeability.	Moderate: Loam surface layer, dusty	Severe: Very slow subsoil permeability
Severe: Very slow subsoil permeability; hardpan at a depth of 12 to 24 inches; very low to low available water holding capacity.	Severe: Very slow subsoil permeability	Moderate: Loam surface layer, dusty.	Severe: Very slow subsoil permeability.
Severe: Very slow subsoil permeability; hardpan at a depth of 12 to 24 inches.	Severe: Very slow subsoil permeability.	Moderate: Slopes, loam surface layer, dusty	Severe: Slopes; very slow subsoil permeability
Moderate: Moderately slow subsoil permeability; low available water holding capacity.	Moderate: Moderate foundation support.	Moderate: Slopes	Severe: Slopes.
Moderate: Slopes; moderately slow subsoil permeability; low available water holding capacity.	Moderate: Moderate foundation support, slope.	Severe: Slopes	Severe: Slopes.
Severe: Moderately slow subsoil permeability, slopes.	Severe: Slopes	Severe: Slopes	Severe: Slopes.
Moderate: Moderately slow subsoil permeability.	Moderate: Moderate foundation support.	Moderate: Slopes	Severe: Slopes.
Moderate: Slopes, moderately slow subsoil permeability.	Moderate: Moderate foundation support; slopes.	Severe: Slopes	Severe: Slopes.
Severe to very severe: Slopes	Severe to very severe: Slopes	Severe to very severe: Slopes.	Severe to very severe: Slopes.
Moderate: Slopes; moderately slow subsoil permeability.	Moderate: Moderate foundation support, slopes, erosion hazard.	Severe: Slopes	Severe: Slopes.
Severe: Slopes	Severe: Slopes, erosion hazard.	Severe: Slopes, erosion hazard	Severe: Slopes; erosion hazard.

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
SnE	Sierra sandy loam, 30 to 45 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well-drained clay loam.[1]
SnF	Sierra sandy loam, 45 to 70 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well drained clay loam.[1]
SoD	Sierra very rocky sandy loam, 3 to 30 percent slopes.	Moderate: Very hard clay loam.	Severe: Moderately slow permeability.	Moderate: Well drained clay loam.[1]
SoE	Sierra very rocky sandy loam, 30 to 45 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well-drained clay loam.[1]
SoF	Sierra very rocky sandy loam, 45 to 70 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well-drained clay loam.
StF	Sierra-Tollhouse-Rock land complex, 45 to 70 percent slopes.[3]			
Sw	Swamp.	Severe: Highly organic.	Severe: Very poorly drained.	High: Very poorly drained.
Ta	Temple loam.	Moderate: Very hard sandy clay loam.	Severe: Moderately slow permeability.	Low: Well-drained loam.[1]
Tb	Temple loam, saline.	Moderate: Very hard sandy clay loam.	Severe: Moderately slow permeability.	Moderate: Conductivity greater than 4.
Tc	Temple loam, saline-alkali.	Moderate: Very hard sandy clay loam.	Severe: Moderately slow permeability.	High: Conductivity greater than 4.
Td	Temple clay loam.	Moderate: Very hard sandy clay loam.	Severe: Moderately slow permeability.	Moderate: Well drained clay loam.[1]
Te	Temple clay loam, saline.	Moderate: Very hard sandy clay loam.	Severe: Moderately slow permeability.	High: Conductivity greater than 4.
Tf	Temple clay loam, saline-alkali.	Moderate: Very hard sandy clay loam.	Severe: Moderately slow permeability.	High: Conductivity greater than 4.
Tg	Temple clay.	Moderate: Very hard sandy clay loam.	Severe: Moderately slow permeability.	High: Well-drained clay.[1]
ThF	Terrace escarpments.	Severe: Undifferentiated material.	Severe: Slopes.	Low.
TkB	Tivy loam, 3 to 9 percent slopes.	Moderate: Hard loam.	Severe: Shallow depth.	Low.
TkD	Tivy loam, 9 to 30 percent slopes.	Moderate: Hard loam.	Severe: Slopes.	Low.
TkE	Tivy loam, 30 to 45 percent slopes.	Moderate: Hard loam.	Severe: Slopes.	Low.
TkF	Tivy loam, 45 to 70 percent slopes.	Moderate: Hard loam.	Severe: Slopes.	Low.
[illegible]	Tivy very rocky loam, 3 to 30 percent slopes.	Moderate: Hard loam.	Severe: Slopes.	Low.
TlF	Tivy very rocky loam, 30 to 70 percent slopes.	Moderate: Hard loam.	Severe: Slopes.	Low.

soils for nonfarm uses—Continued

Landscaping	Recreation: Cottages, utility buildings, shelters	Recreation: Campgrounds, picnic areas	Recreation: Playgrounds, athletic fields
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Severe: Rockiness	Slight to severe: Slopes, rockiness.	Moderate to severe: Slopes	Severe: Slopes, rockiness.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Very high water table.	Very severe: Very poor drainage.	Very severe: Very poor drainage	Very severe: Very poor drainage.
Moderate: Moderately slow subsoil permeability.	Moderate: Moderate foundation support; moderately slow subsoil permeability.	Moderate: Loam surface layer; dusty.	Moderate: Moderately slow subsoil permeability
Moderate: Moderately slow subsoil permeability.	Moderate. Moderate foundation support; moderately slow subsoil permeability	Moderate: Loam surface layer, dusty.	Moderate: Moderately slow subsoil permeability.
Moderate: Moderately slow subsoil permeability saline-alkali affected	Moderate: Moderate foundation support moderately slow subsoil permeability.	Moderate: Loam surface layer, dusty	Moderate: Moderately slow subsoil permeability
Moderate: Moderately slow subsoil permeability.	Moderate. Moderate foundation support; moderately slow subsoil permeability.	Moderate: Clay loam surface layer.	Moderate: Clay loam surface layer; moderately slow subsoil permeability.
Moderate: Moderately slow subsoil permeability saline-alkali	Moderate: Moderate foundation support; moderately slow subsoil permeability.	Moderate: Clay loam surface layer.	Moderate: Clay loam surface layer; moderately slow subsoil permeability.
Moderate: Moderately slow subsoil permeability, saline-alkali affected	Moderate: Moderate foundation support; moderately slow subsoil permeability	Moderate: Clay loam surface layer	Moderate: Clay loam surface layer; moderately slow subsoil permeability
Severe: Clay surface layer, moderately slow subsoil permeability	Moderate: Moderate foundation support; moderately slow subsoil permeability.	Severe: Clay surface layer	Severe: Clay surface layer; moderately slow subsoil permeability.
Very severe: Slopes	Very severe. Slopes	Very severe: Slopes	Very severe: Slopes.
Severe: Low available water holding capacity	Moderate: Erosion hazard	Moderate: Slopes; erosion hazard	Severe: Slopes
Severe: Low available water holding capacity.	Moderate to severe: Slopes, erosion hazard.	Severe: Slopes	Severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe. Slopes.
Severe: Low available water holding capacity.	Slight to severe: Slopes, rockiness.	Moderate to severe: Slopes	Severe: Slopes; rockiness.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
TmF	Tollhouse extremely rocky coarse sandy loam, 30 to 70 percent slopes.	Severe: Soft coarse sandy loam.	Severe: Slopes, shallow depth.	Low.
ToF	Toomes extremely cobbly loam, 30 to 70 percent slopes.	Variable: Rock at a depth of less than 12 inches.	Severe: Slopes.	Low.
ToC	Trabuco loam, 0 to 15 percent slopes.	Slight.	Severe: Slopes, slow permeability.	High: Well-drained light clay.[2]
ToD	Trabuco loam, 15 to 30 percent slopes.	Slight.	Severe: Slopes, slow permeability.	High: Well-drained light clay.[2]
ToE	Trabuco loam, 30 to 45 percent slopes.	Slight.	Severe: Slopes, slow permeability.	High: Well-drained light clay.[2]
ToF	Trabuco loam, 45 to 70 percent slopes.	Slight.	Severe: Slopes, slow permeability.	High: Well-drained light clay.[2]
TpE	Trabuco very rocky loam, 30 to 45 percent slopes.	Slight.	Severe: Slopes, slow permeability.	High: Well-drained light clay.[2]
TpF	Trabuco very rocky loam, 45 to 70 percent slopes.	Slight.	Severe: Slopes, slow permeability.	High: Well-drained light clay.[2]
Tr	Traver sandy loam.	Moderate: Hard heavy sandy loam.	Moderate: Moderate permeability.	High: Conductivity greater than 4.
Ts	Traver sandy loam, moderately deep.	Moderate: Hard heavy sandy loam.	Severe: Moderately slow permeability.	High: Conductivity greater than 4.
Tt	Traver fine sandy loam.	Moderate: Hard fine sandy loam.	Moderate: Moderate permeability.	High: Conductivity greater than 4.
Tu	Traver fine sandy loam, moderately deep.	Moderate: Hard fine sandy loam.	Severe: Moderately slow permeability.	High: Conductivity greater than 4.
TvC	Tretten fine sandy loam, 3 to 15 percent slopes.	Moderate: Hard fine sandy loam.	Moderate to severe: Slopes.	Low.
TvD	Tretten fine sandy loam, 15 to 30 percent slopes.	Moderate: Hard fine sandy loam.	Severe: Slopes.	Low.
TvE	Tretten fine sandy loam, 30 to 45 percent slopes.	Moderate: Hard fine sandy loam.	Severe: Slopes.	Low.
TvF	Tretten fine sandy loam, 45 to 70 percent slopes.	Moderate: Hard fine sandy loam.	Severe: Slopes.	Low.
TwF	Tretten very rocky fine sandy loam, 45 to 70 percent slopes.	Moderate: Hard fine sandy loam.	Severe: Slopes.	Low.
TxC	Trimmer loam, 3 to 15 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well-drained clay loam.[2]
TxD	Trimmer loam, 15 to 30 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well-drained clay loam.
TxE	Trimmer loam, 30 to 45 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well-drained clay loam.[2]
TxF	Trimmer loam, 45 to 70 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well-drained clay loam.[2]
TyE	Trimmer very rocky loam, 30 to 45 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well-drained clay loam.[2]

soils for nonfarm uses—Continued

Landscaping	Recreation		
	Cottages, utility buildings, shelters	Campgrounds, picnic areas	Playgrounds, athletic fields
Very severe: Slopes	Very severe: Slopes, rockiness.	Very severe: Slopes, rockiness.	Very severe. Slopes; rocki-[redacted]
Very severe: Slopes; shallow soil	Very severe: Slopes; cobbly	Very severe: Slopes; cobbly	Very severe: Slopes, cobbly.
Severe. Moderately slow subsoil permeability.	Moderate. Moderate foundation support; slopes; moderately slow subsoil permeability.	Severe Slopes	Severe: Slopes; moderately slow subsoil permeability.
Severe: Moderately slow subsoil permeability	Severe: Slopes	Severe: Slopes ..	Severe: Slopes; slow subsoil permeability.
Very severe: Slopes; slow subsoil permeability.	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes; slow subsoil permeability.
Very severe: Slopes, slow subsoil permeability	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes; slow subsoil permeability.
Very severe: Slopes; slow subsoil permeability.	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes; slow subsoil permeability.
Very severe: Slopes, slow subsoil permeability	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes; slow subsoil permeability.
Moderate to severe: Saline-alkali affected.	Moderate: Moderate foundation support.	Moderate: Sandy loam surface layer; dusty.	Slight.
Moderate to severe. Saline alkali affected.	Moderate Moderate foundation support	Moderate: Sandy loam surface layer; dusty	Moderate: Moderately slow subsoil permeability
Moderate to severe: Saline-alkali affected.	Moderate: Moderate foundation support	Severe: Fine sandy loam surface layer; dusty	Slight.
Moderate to severe: Saline-alkali affected	Moderate Moderate foundation support	Severe: Fine sandy loam surface layer; dusty	Moderate: Moderately slow subsoil permeability
Moderate: Very low to medium available water holding capacity	Moderate: Moderate foundation support.	Moderate to severe: Slopes	Severe: Slopes.
Severe: Slopes	Severe: Slopes	Severe: Slopes	Severe: Slopes.
Very severe Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Slight to moderate Slopes, low to medium available water holding capacity.	Moderate Moderate foundation support.	Moderate to severe: Slopes	Severe: Slopes.
Severe: Slopes	Severe: Slopes	Severe: Slopes	Severe: Slopes.
Very severe Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
TyF	Trimmer very rocky loam, 45 to 70 percent slopes.	Moderate: Very hard clay loam.	Severe: Slopes, moderately slow permeability.	Moderate: Well-drained clay loam.[3]
TzE	Trimmer-Tretten complex, 15 to 45 percent slopes.[2]			
TzF	Trimmer-Tretten complex, 45 to 70 percent slopes.[2]			
TzaA	Tujunga sand, 0 to 3 percent slopes.	Severe: Loose sand	Slight	Low
TzbA	Tujunga loamy sand, 0 to 3 percent slopes.	Severe: Loose loamy sand.	Slight	Low
TzbD	Tujunga loamy sand, 2 to 9 percent slopes.	Severe: Loose loamy sand.	Slight to moderate: Slopes	Low
TzcA	Tujunga loamy sand, gravelly substratum, 0 to 3 percent slopes.	Severe: Loose loamy sand.	Slight	Low
TzdA	Tujunga cobbly loamy sand, 0 to 3 percent slopes.	Severe: Loose cobbly loamy sand.	Slight	Low
TzeB	Tujunga soils, channeled, 0 to 9 percent slopes.	Severe: Loose sand	Severe: Subject to overflow.	Low
VaA	Visalia sandy loam, 0 to 3 percent slopes.	Moderate: Slightly hard sandy loam.	Slight	Moderate: Moderately well drained sandy loam.
VaB	Visalia sandy loam, 3 to 9 percent slopes.	Moderate: Slightly hard sandy loam.	Slight to moderate: Slopes	Moderate: Moderately well drained sandy loam.[3]
VdA	Visalia sandy loam, clay loam substratum, 0 to 3 percent slopes.	Moderate: Slightly hard sandy loam.	Severe: Moderately slow permeability.	High: Moderately well drained clay loam.[3]
VeA	Visalia loam, 0 to 3 percent slopes.	Moderate: Slightly hard loam.	Slight	Moderate: Moderately well drained loam.[3]
VfB	Vista coarse sandy loam, 3 to 9 percent slopes.	Moderate: Hard coarse sandy loam.	Slight to moderate: Slopes	Low
VfC	Vista coarse sandy loam, 9 to 15 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
VfD	Vista coarse sandy loam, 15 to 30 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
VfE	Vista coarse sandy loam, 30 to 45 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
VfF	Vista coarse sandy loam, 45 to 70 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
VgB	Vista coarse sandy loam, shallow, 3 to 9 percent slopes.	Moderate: Hard coarse sandy loam.	Moderate: Slopes	Low
VgD	Vista coarse sandy loam, shallow, 9 to 30 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
VgE	Vista coarse sandy loam, shallow, 30 to 45 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low

soils for nonfarm uses—Continued

Landscaping	Recreation: Cottages, utility buildings, shelters	Recreation: Campgrounds, picnic areas	Recreation: Playgrounds, athletic fields
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Severe: Very low available water holding capacity.	Severe: Severe foundation support.	Severe: Sandy surface layer	Severe: Sandy surface layer.
Moderate: Very low available water holding capacity.	Severe. Severe foundation support.	Moderate: Loamy sand surface layer	Moderate: Loamy sand surface layer.
Moderate Very low available water holding capacity	Severe: Severe foundation support.	Moderate: Loamy sand surface layer; slopes.	Severe: Slopes.
Moderate: Gravelly substratum at a depth of 24 to 48 inches, very low available water holding capacity	Severe: Severe foundation support.	Moderate: Loamy sand surface layer.	Moderate: Loamy sand surface layer.
Severe: Loamy sand surface layer; very low available water holding capacity.	Severe: Severe foundation support	Moderate: Cobbly	Moderate: Cobbly
Moderate: Very low available water holding capacity channeled surface relief, flood hazard.	Severe. Severe foundation support	Moderate: Channeled surface relief variable texture of surface layer.	Severe: Channeled surface relief.
Very slight	Moderate to severe Moderate foundation support	Slight	Slight.
Slight to moderate: Slopes	Moderate to severe Moderate foundation support.	Moderate Slopes	Severe: Slopes.
Moderate Moderately slow substratum permeability	Moderate: Moderate foundation support.	Slight	Moderate: Moderately slow substratum permeability.
Very slight	Moderate: Moderate foundation support.	Slight	Slight
Moderate: Shallow to moderate depth.	Slight	Moderate: Slopes	Severe: Slopes.
Moderate. Shallow to moderate depth; slopes.	Moderate: Slopes	Severe Slopes	Severe: Slopes.
Severe: Slopes	Severe: Slopes	Severe Slopes	Severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe Slopes	Very severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe Slopes	Very severe. Slopes.
Severe Shallow depth; very low available water holding capacity.	Slight	Moderate Slopes, erosion hazard	Severe: Slopes.
Severe: Shallow depth; very low available water holding capacity.	Moderate to severe: Slopes	Severe: Slopes	Severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe. Slopes.

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
VkD	Vista very rocky coarse sandy loam, 9 to 30 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
VkE	Vista very rocky coarse sandy loam, 30 to 45 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
VkF	Vista very rocky coarse sandy loam, 45 to 70 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
VlD	Vista very rocky coarse sandy loam, shallow, 3 to 30 percent slopes.	Moderate: Hard coarse sandy loam	Severe: Slopes	Low
VlF	Vista very rocky coarse sandy loam, shallow, 30 to 70 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
VmD	Vista extremely rocky coarse sandy loam, 3 to 30 percent slopes.	Moderate: Hard coarse sandy loam.	Severe: Slopes	Low
VnD	Vista-Fallbrook coarse sandy loams, 9 to 30 percent slopes.[6]			
VoD	Vista-Fallbrook very rocky coarse sandy loams, 3 to 30 percent slopes.[7]			
VoE	Vista-Fallbrook very rocky coarse sandy loams, 30 to 45 percent slopes.[7]			
VsF	Vista-Fallbrook extremely rocky coarse sandy loams, 30 to 70 percent slopes.[8]			
Wa	Waukena fine sandy loam	Moderate: Very hard sandy clay loam.	Severe: Very slow permeability	High: Conductivity greater than 4
Wb	Waukena loam.	Moderate: Very hard sandy clay loam.	Severe: Very slow permeability.	High: Conductivity greater than 4.
WhB	Wisheylu loam, 3 to 9 percent slopes.	Moderate: Hard loam	Severe: Slow permeability	Moderate: Well-drained clay loam.[5]
WhD	Wisheylu loam, 9 to 30 percent slopes.	Moderate: Hard loam	Severe: Slopes, slow permeability.	Moderate: Well-drained clay loam.[5]
WhE	Wisheylu loam, 30 to 45 percent slopes.	Moderate: Hard loam	Severe: Slopes; slow permeability.	Moderate: Well-drained clay loam.[5]
WhF	Wisheylu loam, 45 to 70 percent slopes.	Moderate: Hard loam	Severe: Slopes, slow permeability.	Moderate: Well-drained clay loam.[5]
WlD	Wisheylu very rocky loam, 3 to 30 percent slopes.	Moderate: Hard loam	Severe: Slow permeability	Moderate: Well-drained clay loam.[5]
Ws	Wunjey fine sandy loam.	Severe: Soft fine sandy loam	Slight	High: Conductivity greater than 4.
Wt	Wunjey silt loam.	Severe: Soft silt loam	Slight	High: Conductivity greater than 4.
YhA	Yokohl loam, 0 to 3 percent slopes.	Slight	Severe: Very slow permeability	High: Well-drained clay.[5]
YhB	Yokohl loam, 3 to 9 percent slopes.	Slight	Severe: Very slow permeability	High: Well-drained clay.[5]

soils for nonfarm uses—Continued

Landscaping	Recreation		
	Cottages, utility buildings, shelters	Campgrounds, picnic areas	Playgrounds, athletic fields
Moderate to severe: Rockiness	Moderate to severe: Rockiness.	Moderate to severe: Slopes	Severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes
Severe: Shallow depth, very low available water holding capacity.	Severe: Rockiness	Moderate to severe: Slopes	Very severe: Slopes, rockiness.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes.
Very severe: Rockiness	Very severe: Rockiness	Severe: Rockiness	Very severe: Rockiness; slopes.
Severe: Saline alkali affected; very slow subsoil permeability.	Severe: Very slow subsoil permeability	Severe: Fine sandy loam surface layer, dusty.	Severe: Very slow subsoil permeability
Severe: Saline alkali affected, very slow subsoil permeability	Severe: Very slow subsoil permeability.	Severe: Loam surface layer, dusty	Severe: Very slow subsoil permeability
Severe: Slow subsoil permeability.	Moderate: Moderate foundation support; slow subsoil permeability	Moderate: Slopes	Severe: Slopes; slow subsoil permeability
Severe: Slow subsoil permeability.	Moderate to severe: Slopes, erosion hazard.	Severe: Slopes	Severe: Slopes, slow subsoil permeability
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes; slow subsoil permeability.
Very severe: Slopes	Very severe: Slopes	Very severe: Slopes	Very severe: Slopes, slow subsoil permeability
Severe: Slow subsoil permeability.	Moderate to severe: Rockiness.	Moderate to severe: Slopes	Severe: Slopes; slow subsoil permeability
Slight to moderate: Saline-alkali affected.	Moderate: Severe foundation support.	Severe: Fine sandy loam surface layer, dusty.	Moderate: Fine sandy loam surface layer.
Slight to moderate: Saline-alkali affected.	Moderate: Severe foundation support.	Severe: Silt loam surface layer, dusty.	Moderate: Silt loam surface layer.
Severe: Hardpan at a depth of 12 to 20 inches, very slow subsoil permeability	Moderate: Very slow subsoil permeability	Slight	Severe: Very slow subsoil permeability.
Severe: Hardpan at a depth of 12 to 20 inches, very slow subsoil permeability	Moderate: Very slow subsoil permeability.	Moderate: Slopes	Severe: Slopes, very slow subsoil permeability.

TABLE 19.—*Ratings and hazards of*

Map symbol	Soil name [1]	Allowable soil pressure	Septic tank filter fields	Corrosivity (untreated steel)
YkA	Yokohl loam, moderately deep, 0 to 3 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay.[2]
YkB	Yokohl loam, moderately deep, 3 to 9 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay.[2]
YlB	Yokohl gravelly loam, 3 to 9 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay.[2]
YmA	Yokohl clay loam, moderately deep, 0 to 3 percent slopes.	Slight	Severe: Very slow permeability.	High: Well-drained clay.[2]

[1] Ratings for soil complexes have not been included in this table. They can be obtained by referring in this table to the soils that make up the complex.
[2] The uppermost 1 foot of soil was not considered in making the ratings.

The soils are generally rated on the basis of soil limitations or hazards. The ratings used are *very slight*, *slight*, *moderate*, *severe*, and *very severe*. If the rating is *very slight*, the soil is relatively free of limitations. If the rating is *slight*, there are few limitations and little or no adjustment is needed. A *moderate* rating means that careful planning, design, and management are needed. If the ratings are *severe*, the limitations make use questionable, and careful planning and above average management are needed. If the ratings are *very severe*, extreme measures are needed to overcome the limitations, and use for the stated purpose generally is not practical. Corrosivity ratings are *low*, *moderate*, and *high*. If the rating is *low* there are few limitations; a *moderate* rating means that careful planning, design, and management are needed; and if ratings are *high*, the limitations make use questionable, and careful planning and above average management are needed.

When soil characteristics not listed in the table were known to affect the ratings, they were considered and the ratings were adjusted accordingly. For example, the San Joaquin and Madera soils generally are moderately deep over a hardpan, and the hardpan affects their use. The single characteristic or quality of the soils that is most restrictive to use determines the rating. The information applies to the soil material within a depth of 5 feet unless otherwise specified.

Ratings for soil complexes have not been included in the table. They can be obtained by referring in the table to the soils that make up the complex.

In the paragraphs that follow a general discussion of the limitations of the soils for selected nonfarm uses is given.

Allowable soil pressure.—The ratings for the soils in the allowable soil pressure column reflect the limitations for building foundations based on Table 28–B Allowable soil pressure, of the Uniform Building Code, 1964 edition (*9*). The surface foot of soil was not considered in making these ratings. An onsite investigation should be made for a more refined determination of foundation design in relation to the soil. In addition to soil texture, consistence, and structure, such characteristics and qualities as permeability, depth to seasonal water table, shrink-swell potential, and shear strength must be considered. Slope also must be considered, for although it is not a factor that directly affects the foundation, it presents problems in construction. Special design for buildings and construction methods are needed on steep slopes. Some of these steep slopes, however, have a definite esthetic advantage, because many of them provide unobstructed access to a desirable view.

Septic tank filter fields.—Soils are rated according to their suitability as septic tank filter fields in table 19. The term *septic tank filter field* refers to a sewage system in which waste is distributed to a central tank and the effluent from the tank is dispersed over a fairly large area of filter field lines buried in the soil.

The main soil characteristics and qualities that determine the suitability of a soil for a filter field are permeability, percolation rate, and drainage; depth to the seasonal water table, hazard of flooding, depth to bedrock or hardpan, and slopes.

A soil has *slight* limitations for filter fields if all of the following apply. Permeability is more than 1.0 inch per hour, depth to a seasonal water table is more than 4 feet, and the soil is well drained to excessively drained, and slopes are 0 to 5 percent.

When pollution is not a problem, a soil has a *moderate* limitation for septic tank filter fields when one or more of the following apply. Permeability is between 1.0 and 0.63 inch per hour; depth to seasonal high water table is between 2 and 4 feet; drainage is somewhat poor or moderately good; depth to bedrock or indurated hardpan is within 40 inches, and slopes are 5 to 10 percent.

A soil has a *severe* limitation for this use, however, if one or more of the following apply. Depth to seasonal high water table is less than 2 feet; drainage is poor or very poor; permeability is less than 0.63 inch per hour; soil is subject to occasional flooding; depth

soils for nonfarm uses—Continued

Landscaping	Recreation: Cottages, utility buildings, shelters	Recreation: Campgrounds, picnic areas	Recreation: Playgrounds, athletic fields
Severe: Very slow subsoil permeability	Moderate: Very slow subsoil permeability	Slight	Severe: Very slow subsoil permeability.
Severe: Very slow subsoil permeability	Moderate: Very slow subsoil permeability	Moderate: Slopes	Severe: Slopes; very slow subsoil permeability.
Severe: Very slow subsoil permeability, 12 to 20 inches deep to hardpan.	Moderate: Very slow subsoil permeability	Moderate: Slopes; gravelly loam surface layer	Severe: Slopes; very slow subsoil permeability.
Severe: Very slow subsoil permeability.	Moderate: Very slow subsoil permeability.	Moderate: Clay loam surface layer	Severe: Clay loam surface layer; very slow subsoil permeability.

[1] Texture of the subsoil or of the material at a depth between 10 and 40 inches.
[2] Properties too variable to be rated for nonfarm use

to bedrock or indurated hardpan is within 40 inches; and slopes are more than 10 percent.

Corrosivity (untreated steel).—The ratings for soil corrosivity in table 19 relate to the physical, chemical, and biological characteristics and qualities of the soils. Structural material, such as untreated steel pipe, corrodes when buried in soil. The most important soil characteristics that affect the rate of corrosion of untreated steel are electrical resistance to the flow of current, total acidity; soil drainage; texture of the subsoil, or of the material at a depth between 10 and 40 inches, and conductivity of the saturation extract (32).

Landscaping.—Soils are rated according to their suitability for landscaping in table 19. The ratings are based on the projected use of the soils for growing lawns, shrubs, and trees, in parks, along highways, and on golf courses. In many areas the natural surface layer is desirable for this purpose and should be saved for later use if construction or modification of the land surface is planned for the site.

The main soil characteristics that determine the suitability of a soil for landscaping are surface texture and depth of the soil, permeability of the subsoil; available water holding capacity; amount of gravel, stones, or rocks in and on the soil, slope, depth to the water table, hazard of flooding, and salinity and alkalinity.

Recreational development.—In general, all soils in this survey area have potential for one or more kinds of recreational use. All of the soils in the area are rated according to their suitability for recreational structures, such as cottages, utility buildings, and shelters; for campgrounds and picnic areas, and for playgrounds and athletic fields. For golf courses and for other forms of recreation having grass or turf requirements, see the soil ratings under *landscaping*. Recreational structures, playgrounds, and athletic fields are used on a year-round basis, and campgrounds and picnic areas are used seasonally.

The main soil characteristics that determine the suitability of a soil for recreational development are allowable soil pressure for foundation support or design; the number of stones and rocks in and on the soil; texture of the surface layer; permeability of the subsoil; erosion hazard; drainage; depth to the seasonal high water table; and the hazards of flooding and ponding. A characteristic may apply specifically to one recreational use, to two uses, or to all three uses, and may vary in limitation rating, depending upon the use.

Allowable soil pressure, for example, is used only in rating the soils for recreational structures; texture of the surface layer is not applicable. Permeability of the subsoil is not applied to ratings for campgrounds or picnic areas, because of seasonal use during dry times of the year. Texture of the surface layer is applied and interpreted only in terms of limitations because of dust. In contrast, texture of the surface layer is important for playgrounds or athletic fields, where a smooth, firm surface is needed. The number of stones and rocks on the surface is least limiting for campgrounds or for picnic areas.

Slope is an important factor in rating the soils, but limitations for the same slope may vary with the intended use. For example, the dominant slope of a soil area is considered a very severe limitation to all three recreational uses if it exceeds 30 percent; it is severely limiting for all uses if it is less than 30 percent but exceeds 15 percent; and it is a severe limitation for campgrounds, picnic areas, playgrounds, or athletic fields if it is more than 8 percent. Soils that have dominant slopes of more than 4 percent are rated as severely limited for playgrounds and athletic fields. Similarly limitations for moderate and slight ratings apply to less steep slopes. These differences in slope limitation ratings reflect the degree of land shaping or leveling that may be needed to prepare sites for the specified recreational uses.

Ratings given for recreational uses do not consider such features as location, accessibility, kind of vegetation, water supply, and other practical or esthetic

features of a given site. An evaluation of these features made at the site being considered, used along with ratings of the soils given in table 20, provides a means of selecting a site for a specific kind of recreation.

Formation and Classification of Soils

In this section the factors that affect the formation of soils in the Eastern Fresno Area are discussed and the major processes of soil formation are described. Then the classification of the soils by higher categories is given.

Factors of Soil Formation

Soil is a natural body on the surface of the earth in which plants grow. It consists of organic and mineral material. Soils differ in their appearance, composition, productivity, and management requirements in different localities or even within short distances in the same locality. The factors that cause soils to differ are (1) the physical and chemical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the biological forces, (4) the relief, or lay of the land, and (5) the length of time the forces of formation have acted on the soil material. The relative importance of each factor differs from place to place, but generally the interaction of all the factors determines the kind of soil that forms in any given place. The influence of each soil forming factor on the soils in the Eastern Fresno Area is described in the pages that follow.

Parent material

Parent material is the weathered rock or unconsolidated material from which soils form. The hardness, grain size, and porosity of the parent material and its content of weatherable minerals greatly influence the formation of soils. There are three main sources of parent material in the Eastern Fresno Area: (1) alluvium, (2) weakly consolidated old alluvial sediment, and (3) hard bedrock. Figure 9 is an approximation of the distribution of geologic materials. It is based, however, only partly upon geologic studies and cannot be termed a geologic map. The pattern shown is the result of field studies of the soils, topographic studies, and purely geologic investigations reported by other workers.

The largest areas of soils are those developed from alluvial material washed from the Sierra Nevada since early Pleistocene times. This material ranges in texture from clay deposited in the lower part of the basin through broad expanses of sands to loamy material deposited on fans to poorly sorted old gravelly or cobbly deposits on remnants of high terraces.

The alluvial material can also be divided into several kinds, depending upon the source rock. The dominant alluvium is that derived from granitic rocks and laid down by major streams that drain the intermediate and higher parts of the Sierra Nevada. Many minor streams that drain the lower foothills have deposited mixed material derived from areas of metasedimentary, metavolcanic, granitic, gabbroic, and serpentinitic rocks. The very old, gravelly and cobbly alluvium was also derived from a wide variety of igneous and metamorphic rocks and is considered to be mixed alluvium.

Most soils in the valleys formed from materials deposited on fans or flood plains. Some, however, formed from weakly consolidated old alluvium exposed by local erosion.

Hard bedrock is extensive in the eastern part of the Area. It consists mainly of (1) lava flows, chiefly basalt, (2) quartz diorite, (3) gabbrodiorite; (4) hornblende schist, (5) serpentine; and (6) quartz mica schist.

The various kinds of parent material are briefly described in the paragraphs that follow.

Recent alluvium.—This material consists of relatively unweathered, predominantly granitic sediment deposited during recent geologic time on fans and flood plains. In the basin flood plain the sediment settled out of slow moving, relatively quiet waters during floods, and it is moderately fine textured and fine textured. From it the Temple and Merced soils formed. The deposits on flood plains and fans of the secondary valleys of the rivers and streams generally are moderately coarse textured or coarse textured, though they are medium textured in places. The Cajon, Chino, Foster, Grangeville, Hanford, Tujunga, and Visalia soils developed from these materials. A few minor streams have deposited recent alluvium from basic igneous rock or a variety of rock sources. In this material Honcut and Nord soils formed. These soils are at the base of Owens Mountain, along Holland Creek, and along parts of Fancher Creek. Differences among these soils are related mainly to differences in mineral composition and drainage.

Large areas of granitic alluvial materials in the valleys have been reworked by wind. This wind-laid material consists of sand in which Calhi, Delhi, and Dello soils formed. Differences among these soils are related chiefly to differences in drainage.

Young alluvium.—This material was deposited earlier than the recent alluvium. It is predominantly granitic, and much of it, particularly that on extensive young fans of the rivers, is somewhat different from recent alluvium in general stratigraphy. Most areas are not subject to further deposition by flooding. On the young fans, several feet of moderately coarse textured material overlies thick silty layers interbedded in a few places with sand. The silty layers may be semi-lacustrine, and the materials probably were laid down in the closing stages of the glaciation of the Sierra Nevada in late Pleistocene time (2). In the better drained parts of the young fans along the rivers the silty substratum phases of the Hanford and Hesperia series have formed. In the naturally less well drained parts within the basin rim zone, the El Peco, Fresno, Pond, Rossi, Traver, and Wunjey soils have formed. Some differences among these soils result from differ-

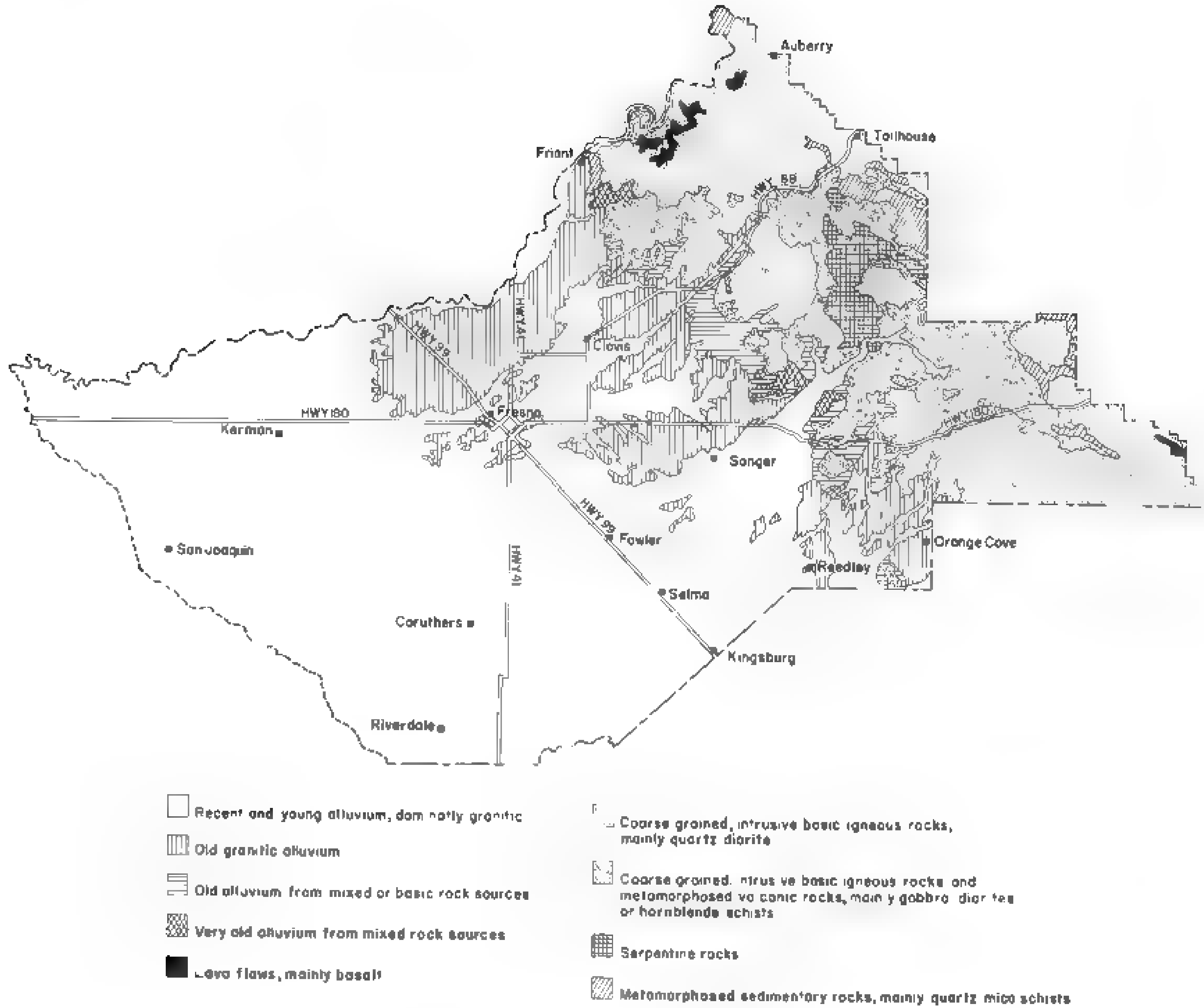

Figure 9.—**Major sources of parent material in the Eastern Fresno Area.**

ences in initial stratification of the parent material. Most differences are related chiefly to drainage and a shallow water table that caused salts and alkali to accumulate.

On the young fans of small streams, the silty substratum generally is lacking. In many places, however, the alluvium overlies compact, older sediment at a depth of less than 5 feet. In these areas the Greenfield and Pachappa soils have developed. Atwater soils formed where the material was reworked by wind, and small areas of Los Robles soils formed in mixed basic igneous alluvium of similar age.

Old granitic alluvium.—This material, on large low river terraces (*2*), probably was deposited during middle Pleistocene time. Textural stratification is similar to that of the young river fans. The material consists of layers of pale-colored silt and sand capped by several feet of coarse textured to moderately coarse textured material. Weathering has made the uppermost layers brown or reddish brown.

In most places the sediment has been altered to a depth of many feet, and the layers therefore are compacted or cemented. From this material the Alamo, Exeter, Madera, and San Joaquin soils formed. All of these soils have a distinctly formed subsoil and a strongly cemented hardpan. The Borden and Ramona soils also formed on terraces in this old alluvium. The material in which they formed, however, probably was slightly younger than that of the other soils. Normally, Borden and Ramona soils have thicker subsoils and lack a compacted substratum within a depth of 5 feet.

In places these terrace soils have been eroded away and the underlying material has been exposed. Pollasky, Rocklin, Cometa, and Montpellier soils have formed in the exposed materials on undulating to rolling or hilly relief. Where fine-textured material has accumulated in swales and drainage is poor, the Hildreth soils formed.

Old alluvium from mixed rock or basic rock.—This material is similar to the old granitic alluvium in age, but its composition is different. It has a lower quartz content and contains more weatherable dark-colored minerals. The material was laid down by small streams flowing from lower foothills. Hornblende schist, gabbro, diorite, metagabbro, metadiorite, and serpentine are the principal sources from which this material was derived. In places material from areas of granitic rock are mixed with this alluvium. Originally this alluvium was medium textured to fine textured. The surface of the fans it occupies was contiguous with the surface of the old granitic alluvial fans. On large areas of these old fans Yokohl soils developed. Subsequent local erosion removed most of these soils with hardpans and exposed the underlying material, from which the Academy soils developed. The Porterville soils formed in fine-textured colluvium, some of which is stony or cobbly. Their position on the landscape suggests they are somewhat younger than the Academy and Yokohl soils. They are on foot slopes or are along the edges of hills of basic igneous rock along the eastern edge of the valley lands.

Very old alluvium from mixed rock.—This material occupies small areas on high terraces near the entrance to the San Joaquin River and Kings River Canyons. It is gravelly or cobbly and probably was deposited in early Pleistocene time (*14*). The terraces are remnants of larger and older deposits long since eroded away. North of Centerville the material contains a large amount of weatherable feldspathic sand, from which the Centerville clays have formed. Near Friant and Tivy Valley, the material is less weatherable, and in this material the Positas and Redding soils formed.

Basalt.—This is basic volcanic rock that originated during the Miocene epoch (*14*). It occurs as a thick, hard cap over river gravel and tuff or overlies granitic rock. In the lower foothills, this fine-grained rock is only slightly weathered. In this material the shallow, stony Hideaway soils developed. The steep, hardened mudflows of basaltic material that skirt the lava caps also are only slightly weathered. From it was derived the parent material of the Toomes soils. In the upper foothills, where precipitation is high, the basalt is weathered deeply. From this material the Aiken soils formed. All of these soils have a loamy surface layer.

Quartz-diorite.—This igneous rock, of late Jurassic time (*14*), has been exposed to weathering fairly recently. The residuum from this rock is coarse textured. Depth of weathering depends upon the amount of moisture available and upon the pattern of the mineral grains and the frequency and orientation of the microjoints. If the microjoints between the mineral grains are numerous and oriented vertically, water can penetrate the surface of the rock readily.

The Ahwahnee, Auberry, Fallbrook, Holland, Sesame, Shaver, Sierra, Tollhouse, and Vista soils formed in material weathered from quartz diorite. They typically have a surface layer of coarse sandy loam. Differences among these soils are related mainly to climate and time. Near Academy, and south of the Kings River, however, large areas of the quartz-diorite contain more dark iron-bearing minerals, mainly pyroxenes, than are present in other areas. The Fallbrook and Sierra soils, which have a subsoil of distinctive reddish colors, formed in materials weathered from this rock. The rest of the quartz-diorite has fewer dark colored minerals, chiefly biotite and hornblende, and provides the parent material from which the Ahwahnee, Auberry, Holland, Shaver, Sesame, Tollhouse, and Vista soils formed.

Gabbro-diorite.—This material, also of late Jurassic time (*14*), includes intrusive gabbro and diorite and metamorphic variations. This rock is somewhat more weatherable than granitic rock under similar climatic conditions. Material weathered from gabbro-diorite ranges from medium textured to fine textured. From it formed soils of the Cibo, Mt. Olive, Tivy, Trabuco, Tretten, Trimmer, and Wisheylu series. Except for the Trabuco and Trimmer soils, these soils lack reddish colors. Differences among these soils are related to the climate and to the composition of the rock. Because calcium feldspars are more weatherable than sodium feldspars, clay minerals tend to form from them somewhat more readily under similar climatic conditions.

This contributes to the differences in the clayey Cibo and Mt. Olive soils and the loamy Tivy soils. In addition calcium carbonate, or lime, has accumulated in the Cibo and Mt. Olive soils from rock mineral weathering and incomplete leaching.

Hornblende schist. This rock, of late Paleozoic or early Mesozoic time (*14*), is dominant where metamorphic rocks occur in the Area. Blasingame and Millerton are the soils that formed in material weathered from hornblende schist. These soils typically are reddish in color because of the high proportion of iron-bearing minerals in this rock.

Serpentine. This ultrabasic intrusive rock of Mesozoic time occurs in the middle part of the foothills (*14*). It was the source of the parent material of the Delpiedra and Fancher soils. These soils are somewhat less fertile than other soils of the foothills because the ratio of calcium to magnesium is fairly low.

Quartz mica schist. The planes of schistosity of this rock dip very steeply. Thus, even though this rock is fine grained, it weathers fairly deeply in the upper foothills where Coarsegold soils formed. In the lower foothills, where the rock is less deeply weathered, soils of the Friant series formed.

Climate

In the Eastern Fresno Area, the summers are warm to hot, and are virtually rainless. The winters are cool, and most of the annual precipitation falls between December and March. By late spring the soils normally are moistened to a depth of several feet, or in the case of hardpan and bedrock soils, to the full depth of the soil.

In the valley, plant growth, mainly grasses and forbs, is rapid in spring, but ceases rather abruptly with the coming of hot weather in May or June and the exhaustion of the limited supply of moisture stored in the soil. A similar growth pattern occurs in the foothills but is somewhat delayed in the spring and may extend later in the summer months because of the lower average daily temperatures at the higher elevations and the greater amount of precipitation. Brush and tree growth in the upper foothills continues long after the grasses have died because their roots are able to tap sources of moisture below the reach of grasses.

The oxidation of the organic matter during the hot summers and the limited growth period in the valley and in the lower foothills permit little accumulation of organic matter. Consequently, all but the poorly drained soils in basins and on flood plains are low in organic matter, compared to the soils of the more humid climate in the upper foothills.

The increase in annual rainfall is gradual from west to east across the valley. The range is from about 8 inches near San Joaquin to about 15 inches at the lower edge of the foothills. Across the low alluvial terraces, the range in annual rainfall is from about 10 to 15 inches. Such a limited range does not account for any important soil differences.

Likewise, temperature variations in the valley are not sufficient to account for appreciable differences between soils. The average annual temperatures ranges from about 63° to 62° F.

The soils that form under the semiarid climate of the valley have a light-colored, massive, neutral to slightly acid surface soil, and a neutral to mildly alkaline subsoil. The older soils on the high terraces are more acid in reaction and have a well-developed profile. These facts suggest the possibility that these soils have been subject to soil-forming processes since the early part of the Pleistocene epoch and that at some previous time the climate was more humid.

In the foothills, the elevation increases from west to east, from about 500 feet to about 4,250 feet. As the elevation increases, the annual precipitation, some of which falls as snow, increases from about 15 to about 35 inches. The average annual temperature decreases from about 62° to about 52° F.

Effects of the higher precipitation and lower temperatures are evident in the vegetation and the soils. Woody and herbaceous vegetation is increasingly abundant, and the organic-matter content of the soils increases from low to moderate. A dark colored, granular surface soil replaces the light-colored, massive surface soil of the valley and lower foothills. Other results are greater soil depth, more distinct subsoil development, and stronger acidity. These effects indicate greater leaching.

Biological forces

Vegetation is dominant among the biological forces that affect soil formation in the Eastern Fresno Area. Animals, insects, bacteria, and other organisms also are important. They add organic matter to the soil and stir and aerate it. Their activity, however, depends in large part upon the vegetation that grows on the soil and provides their food.

On the poorly drained flood plains, the lush growth of vegetation provides the organic matter that gives the Chino, Foster, Grangeville, Merced, Temple, and Visalia soils their dark color. In the terrace areas, on the other hand, pocket gophers produced the pimpled, mima-mound microrelief in areas of soils that have a hardpan at a depth of less than about 3 feet. In deeper soils such microrelief does not occur, even though gophers are present. Seasonal saturation of the soil above the hardpan seems to have altered the living and nesting habits of the gophers so that mound formation was favored (*3*).

In the foothills the plant cover changes with increasing precipitation. Annual grasses, forbs, and scattered oaks dominate on the lower foothills. These gradually give way on the higher foothills to a mixture of oaks, shrubs, and Digger pines that have an understory of annuals and a few perennial grasses. The more abundant vegetation is the reason for the dark color and granular structure of the surface soil, which, in turn, provides a good media for plant growth. This trend can be reduced through the effects of fire and overgrazing. Excessive trampling by grazing animals packs the surface. As a result, more water runs off than penetrates the soil. Then growth of

plants is reduced. In the upper foothills winter freezing and thawing help break up a packed surface soil. Thus, the effects of tramping are not so critical as in the lower foothills.

Relief

Relief through its effect on drainage and erosion has had an important effect on soil development in the Eastern Fresno Area. For example, the basin in the western part of the Area is nearly level, and under natural conditions was drained only by meandering channels that eventually reached the San Joaquin River. As a result poor or very poor natural drainage and a generally high water table were normal for the basin. The high organic-matter content, dark surface color, and mottled olive subsoil colors of the Merced and Temple soils reflect these conditions. The broad young river fans slope gently from the east into the basin. Because the surface of the lower margins of these fans was so close to the level of the natural water table, large areas became saline-alkali through capillary rise and evaporation of the water.

Young and recent fans cover large parts of the valley. They are gently sloping and contain depressions, formed by wind scouring, and remnants of old distributary channels. Most of the soils here have not been affected by the water table, though the soils in the depressions show some evidence of periodic waterlogging.

The low terraces generally are gently undulating, and surface drainage usually is adequate. Water ponds in shallow depressions for short periods, particularly if the soils have a hardpan layer or a compact substratum. Mounded microrelief formerly was common where the soils have a hardpan, but land leveling or cultivating has smoothed most areas. Rainwater collected in the small depressions between the mounds, and as a result, an intricate pattern of soils developed. Typically the soils on the mounds remained well aerated. Examples are the moderately coarse textured Exeter, Madera, and San Joaquin soils. As the result of periodic waterlogging, the Alamo soils in the larger depressions are fine textured, dark colored, and mottled.

Because of erosion some of the terraces are undulating to rolling and have a few steep escarpments. Erosion continues on these slopes at a rate generally proportional to the steepness of the slopes. Soil depth and the degree of soil profile development are directly related to the rate of erosion. Where erosion is rapid, most of the soil material is removed before distinct soil horizons can form. Examples are the Pollasky soils, on fairly steep slopes, that have little or no profile development and are shallow to moderately deep over consolidated sediment. On the less steep slopes, such strongly developed soils as the Academy, Cometa, and Montpellier formed. The factors of time and parent material, however, tend to override the effect of erosion on steep slopes, such as in the dissected high terraces.

In the foothills slopes range from undulating to very steep, and runoff varies accordingly. In the lower foothills soil depth and development tend to follow the general pattern indicated for dissected areas in the terraces. The relationship is less clear, however, and loses much of its significance in the upper foothills where vegetation is denser and provides more protection.

Aspect, or the direction a slope faces, becomes increasingly important in the foothills. It has important effects upon the microclimate of the developing soils. Direction and slope of the soil determine the amount of total heat energy per unit area that is absorbed from the sun. As much as 5° F. difference in the average summer temperature of the soil at a depth of 24 inches has been measured on adjoining north- and south-facing slopes in the general region of the Eastern Fresno Area (*19*). This effect can be quite critical in determining the soil characteristics that develop at certain elevations or on different sides of prominent mountains or ridges. Examples are Trimmer soils, normally in the upper foothills, but that also occur on north slopes of Jesse Morrow Mountain at the lower edge of the foothills.

The correlation of the degree of rockiness, depth of soil, and steepness of slope generally is poor in the foothills. Certain soils, such as the Ahwahnee, Blasingame, Cibo, Sierra, Trabuco, and Tretten, however, show a tendency to be either more shallow or more rocky, or both, on the steep slopes.

Time

The effect of time on soil formation in the Eastern Fresno Area is striking in the valley areas. A study of the stratigraphy and geomorphology of the fans and terraces and the comparison of soil profiles has made it possible to estimate the relative age of a number of the soils. The relative position of the various fans and terraces establishes, to a degree, their comparative ages. In general, the lowest stream bottoms consist of the most recent alluvium and the highest terraces or fans consist of the oldest alluvium.

The highest fans and terraces are composed of mixed gravel from which the Positas soils formed. These soils are well leached and have fairly thick clay subsoils. The lower terraces, fans, alluvial benches, and flood plains consist mainly of nongravelly, sandy sediment deposited on a gentle gradient. In sequence downward the soil development is progressively less distinct. From the oldest to the youngest, the soils formed in these areas are the San Joaquin, Ramona, Greenfield, Tujunga, and Grangeville.

In the foothills most of the land surface has been subject to fairly steady geologic erosion. Presumably most of the soils are younger than those on the high terraces. The effects of changes in climate and of increasing elevation overshadow, for the most part, the changes in profile development that might be ascribed to time alone. Dr. R. O. Hansen, Kearney Foundation, University of California, at Davis, using an uranium-thorium dating technique, investigated the difference in age on an Ahwahnee soil and an Auberry soil, both of which are in the foothills. The study indicated a span of about 20,000 years between the emplacement

of clay in the respective subsoils. The Auberry soil is the older, as also could be inferred from its greater degree of profile differentiation

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationships to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Thus, in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and applied in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. They are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*4*) and later revised (*22*). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965 (*29*). The current system is under continual study. Therefore, readers interested in developments of this system should search the latest literature available (*12, 17, 18*). The soil series of the Eastern Fresno Area are placed in some categories of the current system in table 20. The classes in the current system are briefly defined in the paragraphs that follow.

TABLE 20.—*Soil series classified according to the current system of classification* [1] *and the 1938 system with its later revisions*

Series	Current classification			1938 classification
	Family	Subgroup	Order	Great soil group
Academy	Fine-loamy, mixed, thermic	Mollic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Ahwahnee	Coarse-loamy, mixed, thermic	Mollic Haploxeralfs	Alfisols	Noncalcic Brown soils intergrading toward Brunizem (Prairie) soils.
Aiken	Fine, kaolinitic, mesic	Ultic Palexeralfs	Alfisols	Reddish Brown Lateritic soils.
Alamo	Fine, montmorillonitic, noncalcareous, thermic	Typic Duraquolls	Mollisols	Humic Gley soils.
Atwater	Coarse-loamy, mixed, thermic	Typic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Auberry	Fine-loamy, mixed, thermic	Ultic Haploxeralfs	Alfisols	Noncalcic Brown soils intergrading toward Brunizem (Prairie) soils.
Blasingame	Fine-loamy, mixed, thermic	Typic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Borden	Fine-loamy, mixed, thermic	Typic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Cajon	Mixed, thermic	Typic Xeropsamments	Entisols	Alluvial soils.
Calhi	Mixed, thermic	Typic Xeropsamments	Entisols	Regosols.
Centerville	Fine, montmorillonitic, thermic	Typic Chromoxererts	Vertisols	Grumusols.
Chino	Fine-loamy, mixed, thermic	Aquic Haploxerolls	Mollisols	Humic Gley soils.
Chualar	Fine-loamy, mixed, thermic	Mollic Haploxeralfs	Alfisols	Noncalcic Brown soils intergrading toward Brunizem (Prairie) soils.
Cibo	Fine, montmorillonitic, thermic	Chromic Pelloxererts	Vertisols	Grumusols.
Coarsegold	Fine-loamy, mixed, thermic	Mollic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Cometa	Fine, mixed, thermic	Typic Palexeralfs	Alfisols	Noncalcic Brown soils.
Delhi	Mixed, thermic	Typic Xeropsamments	Entisols	Regosols.
Dello	Mixed, thermic	Mollic Psammaquents	Entisols	Regosols intergrading toward Humic Gley soils.
Delpiedra	Loamy, serpentinitic, thermic, shallow	Mollic Haploxeralfs	Alfisols	Noncalcic Brown soils.
El Peco	Coarse-loamy, mixed, calcareous, thermic	Aquic Durorthidic Xerorthents.	Entisols	Alluvial soils.
Exeter	Coarse-loamy, mixed, thermic	Typic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Fallbrook	Fine-loamy, mixed, thermic	Typic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Fancher	Fine, mixed, thermic	Mollic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Foster	Coarse-loamy, mixed, thermic	Aquic Haploxerolls	Mollisols	Humic Gley soils.
Fresno	Fine-loamy, mixed, thermic	Natric Durixeralfs	Alfisols	Solonetz soils.
Friant	Loamy, mixed, thermic	Lithic Haploxerolls	Mollisols	Lithosols.
Grangeville	Coarse-loamy, mixed, thermic	Aquic Haploxerolls	Mollisols	Humic Gley soils.
Greenfield	Coarse-loamy, mixed, thermic	Typic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Hanford	Coarse-loamy, mixed, nonacid, thermic	Typic Xerorthents	Entisols	Alluvial soils.
Hesperia	Coarse-loamy, mixed, nonacid, thermic	Typic Xerorthents	Entisols	Alluvial soils.
Hideaway	Loamy-skeletal, mixed, acid, thermic	Lithic Xerorthents	Entisols	Lithosols.
Hildreth	Fine, montmorillonitic, thermic	Typic Pelloxererts	Vertisols	Humic Gley soils intergrading toward Grumusols.
Holland	Fine-loamy, mixed, mesic	Ultic Haploxeralfs	Alfisols	Reddish Brown Lateritic soils.
Honcut	Coarse-loamy, mixed, nonacid, thermic	Typic Xerorthents	Entisols	Alluvial soils.

TABLE 20.—*Soil series classified according to the current system of classification[1] and the 1938 system with its later revisions*—Continued

Series	Current classification: Family	Current classification: Subgroup	Current classification: Order	1938 classification: Great soil group
Keefers	Clayey-skeletal, montmorillonitic, thermic	Mollic Palexeralfs	Alfisols	Noncalcic Brown soils.
Keyes	Fine, montmorillonitic, thermic	Typic Durixeralfs	Alfisols	Noncalcic Brown soils.
Los Robles	Fine-loamy, mixed, thermic	Mollic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Madera	Fine, montmorillonitic, thermic	Typic Durixeralfs	Alfisols	Noncalcic Brown soils.
Merced	Fine, montmorillonitic, noncalcareous, thermic	Vertic Haplaquolls	Mollisols	Humic Gley soils.
Millerton	Loamy, mixed, thermic	Lithic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Montpellier	Fine-loamy, mixed, thermic	Typic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Mt. Olive	Fine, montmorillonitic, thermic	Typic Calcixerolls	Mollisols	Grumusols.
Nord	Coarse-loamy, mixed, thermic	Cumulic Haploxerolls	Mollisols	Alluvial soils.
Pachappa	Fine-loamy, mixed, thermic	Mollic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Piper	Coarse-loamy, mixed, calcareous, thermic	Aeric Haplaquepts	Inceptisols	Calcium Carbonate Solonchaks.
Pollasky	Coarse-loamy, mixed, nonacid, thermic	Typic Xerorthents	Entisols	Regosols.
Pond	Fine-loamy, mixed, thermic	Natric Haploxeralfs	Alfisols	Solonetz soils.
Porterville	Fine, montmorillonitic, thermic	Typic Chromoxererts	Vertisols	Grumusols.
Positas	Fine, montmorillonitic, thermic	Mollic Palexeralfs	Alfisols	Noncalcic Brown soils.
Ramona	Fine-loamy, mixed, thermic	Typic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Redding	Fine, kaolinitic, mixed, thermic	Abruptic Durixeralfs	Alfisols	Noncalcic Brown soils.
Rocklin	Fine-loamy, mixed, thermic	Typic Durixeralfs	Alfisols	Noncalcic Brown soils.
Ross	Fine-loamy, mixed, thermic	Aquic Natrixeralfs	Alfisols	Solonetz soils intergrading toward Humic Gley soils.
San Joaquin	Fine, kaolinitic, thermic	Typic Durixeralfs	Alfisols	Noncalcic Brown soils.
Sesame	Fine-loamy, mixed, thermic	Typic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Shaver	Coarse-loamy, mixed, mesic	Pachic Ultic Haploxerolls	Mollisols	Sols Bruns Acides.
Sierra	Fine-loamy, mixed, thermic	Typic Argixerolls	Mollisols	Noncalcic Brown soils intergrading toward Brunizem (Prairie) soils.
Temple	Fine-loamy, mixed, noncalcareous, thermic	Mollic Haplaquepts	Inceptisols	Humic Gley soils.
Tivy	Fine-loamy, mixed, thermic	Typic Haploxeralfs	Alfisols	Noncalcic Brown soils.
Tollhouse	Loamy, mesic, shallow	Entic Haploxerolls	Mollisols	Lithosols.
Toomes	Loamy-skeletal, mixed, nonacid, thermic	Lithic Xerorthents	Entisols	Lithosols.
Trabuco	Fine, mixed, thermic	Mollic Palexeralfs	Alfisols	Noncalcic Brown soils intergrading toward Brunizem (Prairie) soils.
Traver	Fine-loamy, mixed, thermic	Natric Haploxeralfs	Alfisols	Solonetz soils.
Tretten	Coarse-loamy, mixed, mesic	Typic Argixerolls	Mollisols	Brunizem (Prairie) soils.
Trimmer	Fine-loamy, mixed, thermic	Mollic Haploxeralfs	Alfisols	Noncalcic Brown soils intergrading toward Brunizem (Prairie) soils.
Tujunga	Mixed, thermic	Typic Xeropsamments	Entisols	Alluvial soils.
Visalia	Coarse-loamy, mixed, thermic	Pachic Haploxerolls	Mollisols	Alluvial soils.
Vista	Coarse-loamy, mixed, thermic	Typic Xerochrepts	Inceptisols	Regosols intergrading toward Noncalcic Brown soils.
Waukena	Fine-loamy, mixed, thermic	Typic Natrixeralfs	Alfisols	Solonetz soils.
Wisheylu	Fine-loamy, mixed, thermic	Ultic Haploxeralfs	Alfisols	Noncalcic Brown soils intergrading toward Brunizem (Prairie) soils.
Wunjey	Coarse-silty, mixed, calcareous, thermic	Typic Xerofluvents	Entisols	Alluvial soils.
Yokohl	Fine, montmorillonitic, mixed, thermic	Typic Durixeralfs	Alfisols	Noncalcic Brown soils.

[1] Placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

ORDERS: Ten soil orders are recognized in the current system. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. The exceptions, Entisols and Histosols, occur in many different climates.

SUBORDERS: Each order is divided into suborders, primarily on the basis of soil characteristics that seem to produce classes having the greatest genetic similarity. The suborders have a narrower climatic range than the orders. The criteria for suborders are chiefly chemical or physical properties that reflect the presence or absence of waterlogging, or soil differences resulting from the climate and vegetation.

GREAT GROUPS: Each suborder is subdivided into great groups according to the presence or absence of certain significant genetic horizons, certain significant properties of these horizons, if present, or certain significant soil properties at specified depths.

SUBGROUPS: Each great group is subdivided into subgroups. One of these subgroups represents the cen-

tral (typic) segment of the great group, and the others, called intergrades, contain those soils having some properties of soils in another group, suborder, or order.

FAMILIES: Each subgroup is subdivided into families, primarily on the basis of properties important to the growth of plants but also relevant to the behavior of soils used in other ways. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, consistence, and thickness of specified horizons or defined layers.

SERIES: The series consists of a group of soils that formed from a particular kind of parent material and having genetic horizons that, except for texture of the surface soils, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, structure, reaction, consistence, and mineralogical and chemical composition.

New soil series must be established and concepts of some established series, especially older ones that have been used little in recent years, must be revised in the course of the soil survey program across the country. A proposed new series has tentative status until review of the series concept at the State, regional, and national levels of responsibility for soil classification results in a judgment that the new series should be established. Most of the soil series described in this publication have been established earlier. A few are new and in tentative status. All have been classified and correlated according to 1966 criteria.

Five soil orders are represented in the Eastern Fresno Area—*Alfisols, Mollisols, Inceptisols, Vertisols,* and *Entisols*.

Alfisols

The *Alfisols* in this survey area are in the *Xeralf* suborder. These soils formed in a warm, semiarid to subhumid climate having cool, moist winters and long, hot, dry summers. Unless irrigated, the soils are dry throughout the root zone for more than 60 consecutive days during the 3 month period following the summer solstice. The natural vegetation is commonly grasses, or grass that includes some trees and shrubs. Typically the soils have an A horizon that is friable when moist, but that is generally massive and hard when dry and low in organic matter. This horizon overlies a brown, pale reddish-brown, or dull red, clay enriched B horizon. The B horizon is finer textured than the A horizon. It also is less permeable and is commonly leached of calcium carbonate. It ranges from very strongly acid to moderately alkaline, unless it is affected by salts and exchangeable sodium. Base saturation is medium, or greater than 35 percent, to high. If affected by salts and exchangeable sodium, the soils may be strongly alkaline or very strongly alkaline. The pH values and base saturation are fairly uniform or increase with depth.

The *Xeralfs* dominate the central part of the survey area. They have developed in valleys on alluvial terraces; on softly consolidated sediment exposed by normal erosion; and on various kinds of bedrock in the foothills. The *Xeralfs* vary in clay content of the B horizon; in the presence or absence of hardpan; and in the structure of the B horizon and its content of exchangeable sodium.

HAPLOXERALFS

Xeralfs that have a clay enriched B horizon of any texture, and a clear to gradual boundary between the A and B horizons are classified in the *Haploxeralf* great group.

Typic Haploxeralfs.—This subgroup consists of *Haploxeralfs* that have a pale-colored A horizon low in organic matter, and a slightly to moderately clay enriched B horizon. The B horizon has more than 75 percent base saturation. The soils in this subgroup are moderately well drained to somewhat excessively drained.

Nine series are classified in this subgroup. The Atwater, Greenfield, and Tivy series have 3 to 10 percent more clay in the B horizon than in the A horizon. Blasingame, Borden, Fallbrook, Montpellier, Ramona, and Sesame series have 10 percent or more clay in the B horizon than in the A horizon. Time is the principal factor contributing to these differences because the soils occupy young and moderately old land surfaces.

Laboratory tests for the Ramona series indicate the organic carbon content of the surface layer slightly exceeds the limit for this subgroup. The recent use of the site for orchard pruning disposal contributed to this difference.

Mollic Haploxeralfs.—This subgroup is like the *Typic Haploxeralfs*, but it consists of soils that have a dark colored A horizon and higher content of organic matter in the upper 4 inches. The soils are well drained to excessively drained.

Nine soil series are classified in this group. Higher rainfall, slower runoff, and receipt of water from higher lying soils have increased plant growth and the accumulation of organic matter and have produced the dark colored surface horizon. The Ahwahnee, Del piedra, Los Robles, and Pachappa series have formed on younger land surfaces and have slightly more clay in the B horizon than the A horizon. These soils are well drained to excessively drained. The Academy, Chualar, Coarsegold, Fancher, and Trimmer series are on moderately old land surfaces. They have moderately more clay in the B horizon than in the A horizon. These soils are well drained to somewhat excessively drained. Time and parent materials are the principal factors accounting for these differences.

Chualar soils in other survey areas are not hard or very hard and are massive in the A horizon. They are classified as *Typic Argixerolls*.

Lithic Haploxeralfs.—This subgroup is like the *Typic Haploxeralfs*, but it consists of soils overlying parent rock at a depth of less than 20 inches. The soils are well drained to somewhat excessively drained. The Millerton series is classified in this subgroup. These soils have slightly more clay in the B horizon than in the A horizon. Resistance of the parent rock to entry of water and moderately low rainfall are the principal factors explaining the shallow depth of this soil.

Ultic Haploxeralfs.—This subgroup is like the *Typic Haploxeralfs*, but the soils have a dark-colored A horizon and the base saturation of the upper 30 inches of the B horizon is less than 75 percent. These soils are well drained to somewhat excessively drained.

Three series are classified in this subgroup, Auberry Holland, and Wisheylu. Moderate rainfall, and seepage water in the Wisheylu soils, have leached the soils, and favored an increase in content of organic matter. Climate is the principal factor involved in determining the character of these soils.

Natric Haploxeralfs.—This subgroup is like the *Typic Haploxeralfs*, but the B horizon of these soils has more than 15 percent exchangeable sodium. The B horizon also lacks prismatic or columnar structure. These soils are now well drained.

The Traver and Pond series in this subgroup formed under more restricted drainage and a higher water table than exists at the present time. Capillary rise over long periods of time produced a high content of salt and exchangeable sodium. Natural rainfall is low and has been inadequate to leach the salts and remove the exchangeable sodium. The Traver soils typically have accumulated slightly more clay in the B horizon than the A horizon, and Pond soils have accumulated a moderate amount of clay. Time is the principal factor accounting for this. In places the stratification of parent material in both soils, however, has masked this difference. Elsewhere in California, the Traver soils are placed in a coarse-loamy family.

PALEXERALFS

Xeralfs are classified as *Palexeralfs* if they have a clayey B horizon that reflects an increase of more than 15 percent clay across an abrupt boundary between the A and B horizons. They also are classified as *Palexeralfs* if they lack this characteristic but have a thick, clayey B horizon that has little or no decrease in clay content at a depth of 5 feet.

Typic Palexeralfs.—This subgroup consists of *Palexeralfs* that have a pale-colored A horizon, low in content of organic matter, and that have an abrupt boundary between the A horizon and the clayey B horizon. The soils are well drained. The Cometa series is classified in this subgroup. It has formed from compact sediment on old, dissected land surfaces of low terraces. Its characteristics developed over a long period of time.

Mollic Palexeralfs.—This subgroup is like the *Typic Palexeralfs*, but the soils have dark surface colors and higher content of organic matter in the upper 4 inches. The soils are well drained. The Keefers, Positas, and Trabuco series are classified in this subgroup. They formed on old colluvium in the foothills; on the very old, high terraces in the valleys, and on basic igneous rocks in the upper foothills.

Increased precipitation, which results in the production of more organic matter, is the principal factor accounting for the differences between these soils and *Typic Palexeralfs*.

Elsewhere in California, Keefers and Trabuco soils lack the abrupt increase in clay content across the A and B horizons and are classified as *Mollic Haploxeralfs*.

Ultic Palexeralfs.—This subgroup is like the *Typic Palexeralfs* subgroup in this survey area but has dark surface colors, less than 75 percent base saturation in any part of the B horizon, a thick subsoil in which there is little or no decrease in clay content of the B horizon at a depth of 5 feet, and lacks an abrupt change between the A and B horizons. The soils are well drained. Aiken is the only series classified in this subgroup. These soils formed on a remnant of an old basaltic lava flow under conifers, shrubs, and grasses. More effective moisture from higher rainfall, and somewhat lower annual temperatures, have produced more organic matter in the soils, and therefore, darker colors. It has also favored increased leaching. The parent rock has weathered readily and produced very deep soils that have a high clay content. Climate and parent rock are the principal factors accounting for the differences between the soils of this subgroup and those of the typic subgroup.

Elsewhere in California, the Aiken soils are classified as *Xeric Palehumults*, reflecting a somewhat more humid environment and a greater degree of leaching.

DURIXERALFS

Xeralfs that have a silica cemented hardpan at a depth of less than 40 inches are classified as *Durixeralfs*.

Typic Durixeralfs.—This subgroup consists of *Durixeralfs* that have less than 35 percent clay in all parts of the B horizon, or that have less than a 15 percent increase in clay content across an abrupt A and B horizon boundary. These soils are well drained. The Exeter, Keyes, Madera, Rocklin, San Joaquin, and Yokohl series, and the Rocklin, pumiceous variant, are classified in this subgroup.

The Exeter soils have slightly more clay in the B horizon than in the A horizon, and the Rocklin and Rocklin, pumiceous variant, have a moderate amount of clay. The Keyes, Madera, San Joaquin, and Yokohl soils have clay texture in the lower part of their B horizon. These differences appear to be caused by age, or length of time of development.

The origin of a hardpan in soils such as these is not known. One explanation is that rapid warming of the moist soil in spring favors rapid chemical and biological activity, the release of bases, the solution of some silicates, and the release of some iron. Rapid drying follows almost immediately. The result is that silica and iron are irreversibly precipitated. Thus the more slowly permeable substrata are gradually cemented into a nearly impermeable mass.

Elsewhere in California the Exeter soils are placed in a fine loamy family.

Abruptic Durixeralfs.—The soils in this subgroup have more than 35 percent clay in all parts of the B horizon or have more than a 15 percent increase in clay content across an abrupt A and B horizon boundary. They are well drained. Redding is the only series classified in this subgroup. These soils formed on very old land surfaces and have developed a dense clayey B

horizon. Time is the principal factor accounting for differences between these soils and those of *Typic Durixeralfs.* The hardpan formed in a way similar to that described for *Typic Durixeralfs.*

Natric Durixeralfs.—This subgroup consists of hardpan soils with more than 15 percent exchangeable sodium throughout the B horizon. The soils formed under somewhat poor drainage. The drainage has been altered and now the soils are moderately well drained. Fresno is the only series classified in this subgroup. These soils have a moderate amount of clay in the B horizon overlying a lime-silica hardpan. The origin and amount of salts and exchangeable sodium are similar to that described in the *Natric Haploxeralfs* subgroup. The strongly alkaline reaction favors the rapid solution of silicate minerals and the formation of the hardpan. The hardpan formed by accumulation, drying, and cementing of silica in silty layers at a moderate depth. Lime is mainly a secondary cementing agent. Time and relief are the principal factors accounting for the development of these soils.

NATRIXERALFS

Xeralfs that have a B horizon having prismatic or columnar structure and more than 15 percent saturation with exchangeable sodium are classified as *Natrixeralfs.*

Typic Natrixeralfs.—This subgroup consists of *Natrixeralfs* that formed under somewhat poor drainage, but that lack mottles caused by iron. Waukena is the only series in this subgroup. These soils have a thin, dark colored A1 horizon, a bleached A2 horizon, and a clay enriched B horizon. The B horizon has strong columnar structure. These soils are strongly alkaline to very strongly alkaline. The origin and amount of salts and exchangeable sodium are similar to those described for the *Natric Haploxeralfs.*

These soils are at the lower end of alluvial fans and are subject to infrequent deposition. Time and relief are the principal factors accounting for the development of these soils.

Aquic Natrixeralfs.— This subgroup consists of soils formed under poor drainage and that have iron mottles at a depth of less than 30 inches. Rossi is the only series in this subgroup. The A horizon is dark colored and is moderately alkaline to strongly alkaline. The B horizon is very strongly alkaline and has prominent mottles of iron oxides. The increase in clay content is moderate, and the structure is prismatic.

The origin and amount of salts and exchangeable sodium are similar to those described under the *Natric Haploxeralfs.* Time and relief are the principal factors accounting for the development of these soils.

Mollisols

The *Mollisols* in this survey area are in the *Xeroll* and *Aquoll* suborders.

The *Xeroll* suborder consists of soils that formed in a warm, subhumid climate or in a semiarid climate where a natural supplemental source of water extends the growing season. Winters are cool and moist, and summers are hot and dry. Unless irrigated, these soils are dry throughout the root zone for more than 60 consecutive days during the 3-month period following the summer solstice. The natural vegetation consists of grasses, trees and grasses, and of trees and shrubs or chaparral. The soils typically have a dark-colored surface layer more than 10 inches thick that is more than 1 percent organic matter. Base saturation of this layer is more than 50 percent.

The *Xerolls* are in the upper foothills and on recent flood plains in the valleys. They vary in (1) the presence or absence of a clay enriched B horizon; (2) the thickness of the dark surface layer; (3) the base saturation of the upper 30 inches of the profiles; (4) the depth to underlying hard rock; (5) drainage; and (6) in the calcium carbonate content.

The *Aquolls* are similar to the *Xerolls* but are seasonally wet, or are artificially drained and retain specified characteristics associated with poor drainage. They are in depressions on old, low alluvial terraces, and occupy large areas in basins of the San Joaquin Valley. *Aquolls* vary in the presence or absence of a silica cemented hardpan and in having some characteristics similar to *Vertisols.*

HAPLOXEROLLS

Xerolls that have no clay enriched B horizon and generally lack layers strong in calcium carbonate are classified as *Haploxerolls* in this area.

Typic Haploxerolls.—This subgroup consists of *Haploxerolls* formed under good drainage that do not have hard rock at a depth of less than 20 inches. They have more than 75 percent base saturation in the upper 30 inches of the profile, and the organic matter content decreases regularly with depth. Their B horizon lacks clay enrichment, and their characteristic dark-colored surface layer is less than 20 inches thick. No soils in this survey area are classified as *Typic Haploxerolls.*

Entic Haploxerolls.—This subgroup consists of soils that formed under excessive drainage and that are similar to the *Typic Haploxerolls* but lack a B horizon. Tollhouse is the only series classified in this subgroup.

These soils formed in the upper foothills under dense chaparral on steep to very steep slopes that are extremely rocky. They are shallow to well-weathered rock. Time, controlled by relief, climate, and vegetation, combine to account for the profile development of this soil. Because of the steep slopes, much of the soil material is washed away, and the soils maintain a shallow, very youthful profile. Rainfall is high enough to support chaparral which displaces grass on the shallow soils and provides the necessary litter to sustain the content of organic matter and the granular structure.

Cumulic Haploxerolls.—This subgroup consists of soils similar to the soils of the typic subgroup, but that have a dark-colored surface layer thicker than 20 inches, lack a B horizon, and have an irregular decrease in content of organic matter with depth. In this Area, only the Nord series is classified in this subgroup.

These soils formed under moderately good drainage close to the lower edge of the foothills. They formed in deep, recent, stratified alluvium. The local soil cli-

mate is more moist than normal from runoff from surrounding higher lying soils or because of seepage from those soils. Time and climate are the principal factors accounting for the profile characteristics of these soils.

Pachic Haploxerolls.—This subgroup consists of soils similar to the soils of the typic subgroup, but that have a dark-colored surface layer thicker than 20 inches and are without a B horizon. In this Area, only the Visalia series is classified in this subgroup.

These soils formed under moderately good drainage on the flood plains of small streams close to the edge of the foothills and in some foothill valleys. They formed in deep, recent alluvium that has little stratification. Local runoff or seepage from higher lying soils has increased the moistness of the local soil climate. Time and climate are the principal factors accounting for the profile development of these soils.

Pachic Ultic Haploxerolls.—This subgroup consists of soils that are similar to the *Typic Haploxerolls*, but have a dark-colored surface layer thicker than 20 inches and have less than 75 percent base saturation within the upper 30 inches of the profile. Shaver is the only series classified in this subgroup.

These soils are well drained. They formed in the higher parts of the upper foothills in cool, protected sites on hilly to steep terrain in deeply weathered material from granitic rock. A climate of relatively cool year-round temperature and moderately high precipitation in winter is the principal factor in the development of these soils.

Lithic Haploxerolls.—This subgroup consists of soils that are similar to the *Typic Haploxerolls* but that lack a B horizon and overlie hard rock at a depth of less than 20 inches. Friant is the only series classified in this subgroup.

The Friant soils are well drained. They formed in material weathered from fine-grained rock on hilly to steep terrain in the lower foothills. Parent rock is the principal factor accounting for the characteristics of these soils. The rock is slowly weatherable under the local climatic conditions and results in a shallow soil. This shallow soil is fertile enough, however, to support a grass cover capable of developing and maintaining a moderate content of organic matter in the shallow soil. Additional moisture storage for use by the vegetation is available in joints in the rocks underlying the soil.

Aquic Haploxerolls.—This subgroup consists of soils similar to *Typic Haploxerolls* but that lack a B horizon and have characteristics associated with moderate wetness. The Chino, Foster, and Grangeville series are classified in this subgroup.

These soils formed on somewhat poorly drained parts of recent flood plains and recent fans of the rivers and of several streams in the Area. The Foster and Grangeville soils formed in moderately coarse textured alluvium, but the Chino soils formed in medium textured to moderately fine textured alluvium. Time, and relief, as it influences drainage, have been the controlling factors in the development of the characteristics of these soils.

ARGIXEROLLS

Xerolls that have clay enriched B horizons, a clear to gradual boundary between the A and B horizons, and lack strong calcium carbonate layers are classified in the *Argixeroll* great group.

Typic Argixerolls.—This subgroup consists of *Argixerolls* that formed under good to somewhat excessive drainage and that do not have hard rock or weathered rock at a depth of less than 20 inches. The characteristic dark-colored surface layer is less than 20 inches thick, and the subsoil has more than 75 percent base saturation throughout. Sierra and Tretten series are classified in this subgroup.

The Tretten soils have slightly more clay in the B horizon than in the A horizon. They overlie weathered basic igneous parent rock in the upper foothills on relatively young, steep land surfaces. The Sierra soils have a moderate amount of clay in the B horizon. They overlie deeply weathered granitic parent rock on somewhat less steep, older land surfaces near the Tretten soils. Time and climate, principally rainfall, are the combined factors that determine and distinguish the characteristics of these soils.

Elsewhere in California, Sierra soils are classified as *Ultic Haploxerolls*.

CALCIXEROLLS

Xerolls that have very strongly calcareous layers at a depth of less than 5 feet of the soil surface and are calcareous throughout the profile are classified as *Calcixerolls* in this Area.

Typic Calcixerolls.—The subgroup consists of *Calcixerolls* that formed under good drainage and that typically have a dark-colored surface layer no thicker than 20 inches and do not overlie hard rock at a depth of less than 20 inches. Mt. Olive is the only series classified in this subgroup.

These soils formed in the lower foothills in material weathered from basic igneous rock. The parent rock weathers readily and forms much clay and calcium carbonate. The moderately low rainfall is insufficient to leach these clayey soils of the lime that accumulates in the lower part of the soil. Parent material is the principal factor determining the character of this soil.

HAPLAQUOLLS

Aquolls that lack a hardpan or very strongly calcareous layer and have no clay enriched B horizon are classified as *Haplaquolls*.

Vertic Haplaquolls.—This subgroup consists of *Haplaquolls* that are mainly fine textured and develop some deep cracks when dry. Merced is the only series classified in this subgroup.

These soils formed under poor drainage, in marshy areas in the basins of the San Joaquin Valley. Under improved drainage, these soils dry out in summer, unless irrigated, and the shrink and swell properties of the clays have characteristics similar to *Vertisols* on drying and wetting. Relief, as it influences drainage, is the dominant factor in the development of these soils.

DURAQUOLLS

Aquolls that have a hardpan cemented by silica at a depth of less than 40 inches are classified as *Duraquolls*.

Typic Duraquolls.—This subgroup consists of *Duraquolls* that lack a clay enriched B horizon. Alamo is the only series classified in this subgroup. These soils have formed under poor drainage in depressional areas on low terraces in the valleys near well-drained soils that have a hardpan, the *Durixeralfs*. Relief, as it affects drainage, is the principal factor in the development of the characteristics of these soils.

Inceptisols

The *Inceptisols* in this survey area are in the *Ochrept* and *Aquept* suborders.

The *Ochrepts* formed in a warm, semiarid climate that had cool, moist winters and hot, dry summers. The natural vegetation is commonly trees and grasses but includes some shrubs. The soils typically are never saturated with water and have a pale-colored A horizon that is friable when moist and massive and hard when dry. It also is low in content of organic matter. The B horizon is similar to the A horizon in color and has little clay or no accumulated clay. The *Ochrepts* occupy large areas in the lower foothills on granitic rocks.

The *Aquepts* are similar to *Ochrepts* in profile development but are saturated with water at some time of the year or are artificially drained. At a depth of less than 20 inches, these soils have characteristics associated with wetness.

The *Aquepts* are in the valley basin. They vary in the color of the A horizon and the substratum.

XEROCHREPTS

Ochrepts, unless irrigated, are dry throughout the root zone for more than 60 consecutive days during the 3-month period following the summer solstice, and are classified in the *Xerochrept* great group.

Typic Xerochrepts.—This subgroup consists of well drained to somewhat excessively drained soils. These soils are sufficiently leached to lack calcium carbonate accumulation but have a base saturation of at least 60 percent in part of the upper 30 inches of the profile. They are not fine textured and do not overlie hard, unweathered rock at a depth of less than 20 inches. Vista is the only series classified in this subgroup.

These soils are moderately coarse textured and are moderately deep to weathered granitic rock. They are rolling to very steep and are rocky in places. Climate is the principal factor that determines the character of these soils. Rainfall is lower than in the upper foothills where soils that have a more strongly expressed horizon have formed on the same kind of parent rock.

HAPLAQUEPTS

Aquepts that do not have the thick, dark-colored surface layer characteristic of *Mollisols* and are not dominated by volcanic ash material are classified in the *Haplaquept* great group.

Typic Haplaquepts.—This subgroup consists of soils that have dull colors in the upper 30 inches of the profile. The A horizon is light colored, or it is less than 6 inches thick and is dark colored. They also have less than 1 percent organic matter in the A horizon and the content decreases regularly with depth. In the Eastern Fresno Area, no series is classified in this subgroup.

Mollic Haplaquepts.—This subgroup is like the typic subgroup, but it consists of soils that have dark-colored A horizons more than 6 inches thick but lack the qualifications for the dark surface layers of *Mollisols*. Temple is the only series in the survey area classified in this subgroup.

These soils have formed under poor drainage, mainly along the edge, or in the southern part of the basin land. They formed in moderately fine textured alluvium deposited mainly by the Kings River. Relief, as it influences drainage, and the texture of the parent alluvium are the principal factors that account for the characteristics of this series.

Aeric Haplaquepts.—This subgroup is like the typic subgroup but consists of soils that have brighter colors in the upper 30 inches of the profile and that have a grayish-brown A horizon. Piper is the only series classified in this subgroup.

These soils formed on low knolls or ridges in the basin lands. The parent material consists of moderately coarse textured alluvium deposited on natural levees of sloughs that meander across the basin. The soils are strongly calcareous, and in many places they are affected by salts and alkali from former rise and evaporation of the low ground water. Lime has been partly leached from the B horizon, but the soils are still calcareous. Relief, as it affects drainage and proximity to a water table, and the texture of the parent alluvium are the principal factors that account for the development and characteristics of these soils.

The Piper series are marginal in classification to the *Halaquept* great group on the basis of having a sodium saturation in excess of 15 percent within the upper 20 inches of the profile. These soils, however, are no longer saturated with water to a depth of less than 40 inches, and are all fairly easy to reclaim. The sodium saturation therefore is not considered a reasonably permanent characteristic for classification.

Vertisols

The *Vertisols* in this survey area are in the *Xerert* suborder. These soils are fine textured throughout and consist in part of clays that swell and shrink significantly on wetting and drying. They formed in a warm, semiarid climate having cool, moist winters and hot, dry summers. The natural vegetation consists of grasses. Unless irrigated, these soils dry in summer and crack open from the surface downward to a depth of at least 20 inches. Because of negligible rainfall in summer, the cracks remain open for more than 60 consecutive days each year. These soils typically have an A horizon that is firm and massive when moist, but becomes granular, or blocky and hard or very hard, when dry. The A horizon has a moderate to low con-

tent of organic matter. Surface soil falls into cracks in the soils when they are wet and causes internal displacement. Because of the internal churning that takes place in these soils, development of a B horizon is not possible. Also a result of this action is the occurrence of intersecting slickenside faces in the clayey substratum.

The *Xererts* occur in places along the eastern edge of the valley and in parts of the lower foothills. They formed in fine-textured colluvium and in material from highly weatherable types of bedrock. The *Xererts* vary in color and drainage.

CHROMOXERERTS

Xererts that have mainly bright colors to a depth of at least 12 inches are classified in the *Chromoxerert* great group.

Typic Chromoxererts.—This subgroup consists of *Chromoxererts* that are well drained and lack medium or pale colors when moist in the upper 12 inches of the profile. These soils lack evidence of downward clay movement at a depth of less than 40 inches, typical of soils in the *Alfisol* order. Centerville and Porterville series are classified in this subgroup.

The Centerville soils are moderately deep and formed on dissected high terraces in material from exposed sediment that readily weathers to clay that has high shrink-swell characteristics. The Porterville soils are deep and formed in thick deposits of clayey colluvium that skirt basic igneous hills on the lower edge of the foothills. Parent material is the principal factor that accounts for the characteristics of these soils. Thickness of the solum is the principal characteristic that accounts for difference in the two series.

PELLOXERERTS

Xererts that have mainly dull colors to a depth of at least 12 inches are classified in the *Pelloxerert* great group.

Typic Pelloxererts.—This subgroup consists of soils that have dull colors to a depth of at least 40 inches. If these soils are brighter colored below a depth of 12 inches, they show characteristics associated with poor drainage. All have dark or dull medium colors in the upper 12 inches of the profiles. Hildreth is the only series in the survey area classified in this subgroup.

Hildreth soils formed in poorly drained swales on low terraces and on lower foothills, chiefly from fine-textured alluvium washed from granitic rock. The soils are seasonally saturated with water. Relief, as it influences drainage, and fine-textured parent alluvium are the principal factors accounting for the characteristics of these soils.

Chromic Pelloxererts.—This subgroup is like the typic subgroup but consists of well drained to somewhat excessively drained soils that have brighter colors at depths of more than 12 inches. Cibo is the only series classified in this subgroup.

The Cibo soils formed in material weathered from basic igneous rock on undulating to very steep terrain that was rocky in many places. They are in the lower foothills. The parent rock has a relatively high proportion of dark minerals. Most of the rock is made up of feldspars that readily weather to clay that has high shrink-swell characteristics. Rainfall is moderately low, and the dark minerals weather less readily than under higher rainfall and persist in the soil matrix to influence the darkness of its color. Parent material is the principal factor influencing the characteristics of these soils.

Elsewhere in California, the Cibo series is classified with the *Typic Chromoxererts*. Its classification in this survey area is marginal, and in places, the soils range in color characteristics to that of *Typic Chromoxererts*.

Entisols

The *Entisols* in this survey area are in the *Orthent*, *Fluvent*, *Psamment*, and *Aquent* suborders. These soils formed in a warm, semiarid climate under cool, moist winters and long, hot and dry summers. All of these soils lack a B horizon, and they generally have low content of organic matter. Unless irrigated, the soils in the *Orthent*, *Fluvent*, and *Psamment* suborders generally are dry in most years. The soils in these suborders are dry throughout the root zone for more than 60 consecutive days during the 3-month period following the summer solstice. The natural vegetation is commonly grasses, or grasses and a few trees. Except for the soils in the *Aquent* suborder, these soils are well drained and have never been saturated with water throughout their profile for long periods of time. The natural vegetation for *Aquent* soils is grasses, other plants, and trees that tolerate wetness.

The *Orthents* are loamy very fine sand, or are finer textured, to a depth of 40 inches or more. The content of organic matter decreases with depth to less than 0.2 percent carbon at a depth of 50 inches. These soils are dominant on young fans of the two rivers in the survey area and are widespread on parts of the recent floodplains of the rivers and smaller streams. Some of the soils are on dissected sloping areas of older alluvial fans, and on lava and old mudflows in the lower foothills.

The *Fluvents* are similar to the *Orthents* in texture, but they typically are nearly level and the content of organic matter does not reach a value lower than 0.2 percent carbon at a depth of 50 inches. The areas are small and are on young alluvial fans of the San Joaquin River.

The *Psamments* are sandy soils. They have a texture of loamy fine sand or coarser in all parts of the profile to a depth of 40 inches or more. They occur mainly on young fans of the Kings River and the San Joaquin River, but some areas are on the flood plains of these rivers.

The *Aquents* are poorly drained and retain color characteristics typical of wetness within a depth of 20 inches.

These soils are dry in summer and are moist in part of the root zone late in winter and in spring for more than 90 days. The *Orthents*, *Fluvents*, and *Psamments* of this Area have therefore been placed in the *Xerorthent*, *Xerofluvent*, and *Xeripsamment* great groups, respectively. The texture in the *Aquent* suborder at a depth between 10 and 40 inches or more is

loamy fine sand or coarser. The soils of the *Aquents* suborder in this Area, therefore, have been placed in the *Psammaquent* great group.

XERORTHENTS

Typic Xerorthents.—This subgroup consists of pale-brown to brown *Xerorthents* that are low in content of organic matter. Unless irrigated, these soils are never saturated within a depth of 5 feet. They lack cemented layers within a depth of 40 inches, or hard rock layers within a depth of 20 inches. The Hanford, Hesperia, Honcut, and Pollasky series have been classified in this subgroup. The Hanford, Hesperia, and Honcut soils formed on recent or young alluvial deposits. The Pollasky soils formed on firm sandy or silty sediment, fairly recently exposed by dissection of old terraces. A relatively short length of time for soil formation processes to act and thick deposits of parent alluvium, or the presence of thick, permeable, weakly consolidated sediment, are the chief factors determining characteristics of soils in this subgroup.

The Hesperia series is classified as a *Typic Torriorthent* under drier conditions than exist in the survey area, where the root zone is not moist in some parts for more than 90 consecutive days.

Lithic Xerorthents.—This subgroup consists of brown to dark-brown soils that differ from the *Typic Xerorthents*, chiefly in having hard rock at a depth of less than 20 inches. The Hideaway and Toomes series are classified in this subgroup. These soils formed on gently sloping old basaltic lava flows and very steep mud flows, respectively, in the lower foothills. They are very cobbly or stony. They formed under somewhat higher rainfall than the *Typic Xerorthents*, but the dense parent basalt or mud-flow material has resisted weathering and is the principal factor determining the character of the soils in this subgroup. The Hideaway soils are medium acid to strongly acid, and the Toomes soils are slightly acid to neutral. Because of the very steep and warmer, south-facing slopes of the Toomes soils, internal leaching is less in these soils than in the Hideaway.

Elsewhere in California, the Toomes soils are less stony or cobbly and are somewhat deeper than those in the survey area and are classified in a loamy family of *Lithic Xerochrepts*.

Aquic Durorthidic Xerorthents.—This subgroup consists of soils that are pale colored and strongly alkaline and that have lime-silica cemented layers at a depth of less than 40 inches. The reaction reflects the past existence of a water table within a depth of 5 feet. The origin and amount of salts and exchangeable sodium in the soils of this subgroup is similar to that described under the *Natric Haploxeralfs*. The cemented layers formed in a way similar to that described for the *Natric Durixeralfs*.

El Peco is the only series classified as *Aquic Durorthidic Xerorthents*. A relatively short duration of time and somewhat poor drainage account for the development of this soil.

XEROFLUVENTS

Typic Xerofluvents.—In this survey area, the *Xerofluvents* consist of pale-colored soils that are well drained. They lack cemented layers within a depth of 40 inches and are not fine textured. Wunjey is the only series classified in this subgroup. The soils are moderately alkaline to strongly alkaline and have some excess salt accumulation. This reflects a past condition where the water table, though deeper than 5 feet, was sufficiently close to permit capillary rise of moisture into the soils. Subsequently a slow accumulation of salts occurred through evaporation. Incomplete leaching under low rainfall and continued cycling of the salts within the soils developed sufficient levels of exchangeable sodium to account for the more alkaline reaction.

The coarse silty family in which these soils are placed is reflected in their high available water holding capacity. This favors and accounts for the higher content of organic matter at a depth that determines the classification of this soil.

XEROPSAMMENTS

Typic Xeropsamments.—This subgroup consists of deep soils that lack thin layers of clay accumulation, or dark colored mottles at a depth of less than 40 inches. These soils are somewhat excessively drained. The Cajon, Calhi, Delhi, and Tujunga series are classified in this subgroup. The Cajon and Tujunga soils formed in coarse-textured recent alluvium. Much of the sand is coarse or very coarse and is subangular in shape. Pebbles or cobblestones are common in some areas. The Calhi and Delhi soils formed in wind-laid sand that generally is less coarse than that of Cajon and Tujunga soils and the particles are more subrounded. The coarseness of the parent material, the dry climate, and the youthfulness of the parent deposits are the principal factors accounting for the development of these soils.

Under drier conditions than exist in this survey area, the root zone is not moist in some part for more than 90 consecutive days and the Cajon series is classified with the *Typic Torripsamments*.

PSAMMAQUENTS

Mollic Psammaquents.—This subgroup consists of deep soils that have a moderately dark colored surface layer. The soils formed under somewhat poor to poor drainage. Dello is the only series classified in this subgroup. These soils formed in hollows in areas modified by wind on young fans and in sandy channels on recent flood plains. Surface relief, as it influences local drainage, and sandiness of the youthful parent material are the principal factors accounting for the development of these soils.

The Dello soils have been classified as *Typic Psammaquents* elsewhere in California, but they are marginal in their range of surface colors to the *Mollic Psammaquents*.

Laboratory Analyses

In this section the results of the physical and chemical analyses of representative soils are given. Then results of the mineralogical analyses of clay fractions of some representative soils are shown.

Physical and Chemical Analyses [1]

The results of the physical and chemical analyses of representative soils of the Area are given in tables 21 and 22. The soil samples were screened through a 2-millimeter, round-holed sieve. The aggregates were crushed with a rubber-tipped pestle. After they had been rubbed relatively clean, the gravel and stones larger than 2-millimeters in diameter were weighed to determine the percentage of gravel and were then discarded. The material that passed through the sieve was thoroughly mixed, and aliquot parts of this were used

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TABLE 21.—*Physical and chemical analyses of some representative soils of*

[Refer to the section "Descriptions of the Soils" for descriptions of soil profiles in this table. If

Soil name and sample number	Horizon	Depth	Particle-size distribution					
			Gravel (76–2 mm.)	Very coarse sand (2–1 mm.)	Coarse sand (1–0.5 mm.)	Medium sand (0.5–0.25 mm.)	Fine sand (0.25–0.10 mm.)	Very fine sand (0.10–0.05 mm.)
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Academy loam (62–Calif.–10–14) [1]	Ap	0–6	2.0	1.0	9.0	1.9	9.2	25.6
	B1t	6–12	1.0	3.7	8.0	7.6	9.1	14.5
	B21t	12–20	2.0	3.6	7.0	6.4	11.4	17.7
	B22t	20–30	2.0	2.6	7.1	8.2	10.0	17.9
	C	30	2.0	5.6	13.1	10.8	14.3	12.4
Ahwahnee coarse sandy loam (56–10–5)	A1	0–10	13.3	14.8	13.7	17.5	20.5	12.0
	B2t	10–36	14.5	11.3	16.7	13.7	22.5	11.9
Aiken loam (62–Calif.–10–35) [1]	A11	0–4	4.0	4.5	7.4	6.2	8.8	6.4
	A12	4–9	4.0	3.3	6.0	5.2	6.2	5.2
	B11t	9–21	2.0	2.2	5.5	4.9	8.1	6.5
	B12t	21–30	1.0	2.0	4.1	3.8	5.9	4.9
	B21t	30–84	1.0	1.0	1.5	1.3	2.6	3.0
	B22t	84–120	1.0	.3	.1	.6	1.4	3.7
Atwater loamy sand (62–Calif.–10–4) [1]	Ap	0–9		2.1	21.4	27.6	32.4	7.1
	A3	9–24		1.9	16.2	35.0	20.9	14.6
	B2t	24–43		1.7	17.2	20.8	29.3	8.7
	C1	43–60		2.0	20.2	24.6	23.0	14.0
Auberry coarse sandy loam (56–10–6)	A1	0–7	9.2	14.6	12.7	14.6	18.5	11.5
	A3	7–12	8.1	12.1	15.8	11.4	18.6	11.6
	B1t	12–16	8.8	12.6	10.8	14.0	18.3	11.2
	B2t	16–35	3.7	9.4	12.6	9.9	18.9	13.5
	B3	35–42	7.0	11.0	15.6	11.1	20.8	14.1
	C	42–60		19.2	17.5	18.5	20.3	11.5
Blasingame loam (60–Calif.–10–1).	A1	0–1						
	A3	1–6						
	Bt	6–10						
	B21t	10–26						
	B22t	26–32						
	C	32						
Borden loam (58–Calif.–10–9)	Ap1	0–4	.9	2.6	7.6	11.1	21.1	11.6
	Ap2	4–7	1.9	2.2	7.0	10.5	22.1	12.2
	B1	7–12	.6	2.0	6.9	10.9	21.8	12.2
	B2t	12–30	.2	.5	2.8	8.2	24.0	10.4
	B3ca	30–38	.1	.2	2.3	11.6	34.4	11.6
	C	38–60	.2	.3	2.6	10.7	31.8	13.2
Calhi loamy sand (58–Calif.–10–5)	A11	0–2	0	.6	15.9	19.8	23.7	17.5
	A12	2–11	0	.6	15.5	19.0	24.3	18.8
	C1	11–31	0	.8	18.6	20.1	23.6	19.1
	C2	31–54	0	.6	18.0	20.4	24.7	19.5
	C3	54–60	0	.7	26.0	23.8	19.7	15.1
Centerville clay (PS43)	A11	0–20	12.4	1.9	3.1	2.6	4.5	5.2
	A12	20–32	12.4	12.2	3.3	2.6	4.5	5.0
	C	32	81.6					
Chino loam (62–Calif.–10–20) [1]	A11	0–3	0	3.7	9.0	5.2	20.1	12.8
	A12	3–12	0	2.9	7.1	3.2	18.2	12.9
	A13	12–18	0	1.6	2.7	1.4	8.8	16.3
	IIC1	18–25	0	.3	.5	.8	33.4	27.5
	IIC2	25–60	0	.1	.4	.9	47.5	24.4

for the laboratory analyses. Methods used in obtaining the data are described in the paragraphs that follow.

Particle-size distribution.—The amount of sand, as shown in table 21, was determined through the use of 10 grams of ovendried soils to which water and calgon (a sodium hexametaphosphate) had been added. This mixture was shaken overnight in a reciprocating shaker. The soil was then wet sieved through a 300-mesh screen, transferred to an evaporating dish, ovendried, and weighed. The total sand was expressed in percentage of the weight of the original ovendried sample. The dried sand was then separated into fractions through a nest of sieves in a mechanical shaker, and each fraction was weighed.

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there is no entry in a column, test showed no data or test was not made. < = less than]

Particle-size distribution—Continued									
Total sand	Silt (0.05–0.002 mm.)	Clay (less than 0.002 mm.)	Bulk density	Moisture held at tension of 15 atmospheres	Reaction	Calcium carbonate	Phosphate	Organic carbon	Carbon nitrogen ratio
Percent	Percent	Percent	Gm./cc	Percent	pH	Percent	P.p.m.	Percent	
48.7	31	20	1.8	7.4	5.7			0.81	14
42.9	31	26	2.0	9.2	5.7			.44	12
46.7	21	32	2.0	11.5	6.1	.	.	.43	13
44.0	24	32	2.0	12.2	6.7	.		.16	
56.2	22	22	2.0	9.1	7.2	<1			
78.2	11	11	1.6	4.4	6.3		0.75	.59	12
76.1	10	14	1.6	5.2	6.1		1.1	.18	
33.3	40	27	1.6	19.4	6.1			5.86	26
27.9	40	32	1.3	19.3	6.0			3.64	27
27.0	30	37	1.3	18.8	5.9			1.84	21
20.7	36	44	1.6	18.6	5.7			.76	10
9.3	30	61	1.5	21.8	5.6			.52	15
6.1	33	61	1.6	26.0	5.6			.24	15
90.6	5	4	1.7	1.4	6.1			.20	14
81.5	8	10	1.8	1.4	6.2			.10	9
77.7	7	15	1.7	2.8	6.3			.08	8
87.8	4	8		2.8	6.2			.02	3
71.9	14	14	1.5	6.1	6.8		.31	1.30	13
69.5	15	15	1.6	5.7	6.0		.07	.83	12
66.0	15	18	1.7	6.9	6.0	..	.02	.73	17
63.2	17	20	1.8	8.3	5.8		<.02	.17	12
72.6	14	13	1.8	5.5	5.6	..	<.02	.10	11
86.0	6	8	..	4.0	6.6		.09	.08	16
57.6	29	13	1.7	6.2	6.4		[1]5.5	1.54	10
53.2	27	20	..	6.5	6.6	...	3.2	.44	12
50.7	27	32	..	7.4	6.6		.4	.30	12
43.0	25	33		12.2	6.7		.4	.24	10
47.8	25	27	2.0	10.6	7.2	.	.4	.10	6
72.0	18	10		6.2	8.0	.	.4	.08	20
54.0	26	20	1.7	6.6	7.3	...	1.05	.67	9
54.0	26	20	1.7	6.6	7.1		.98	.63	9
53.8	26	20	1.8	7.1	7.0		.22	.47	8
45.9	24	30	1.8	10.6	7.8	<1	.17	.12	6
60.1	17	23	1.8	9.6	7.9	<1	.21	.00	4
58.8	21	20	1.8	8.3	8.1	<1	.21	.07	6
78.5	17	5	1.6	2.1	7.7	<1	.78	.61	10
78.3	16	6	1.6	2.1	8.4	1	.35	.28	10
82.0	13	5	1.7	1.4	8.6	<1	.27	.06	30
83.2	13	4	1.7	1.3	8.7	..	.42	.03	6
85.3	12	3	1.7	1.8	9.0		3.09	.02	3
17.3	39	64	2.0		6.5	<1	.08	.62	13
27.5	17	55			7.6	1	.14	.53	18
	..	..			7.8	1			
50.8	29	20		19.2	6.2			6.81	16
44.8	33	23	1.7	12.1	6.7	..	...	1.24	14
30.8	38	31	1.7	15.9	7.0			.74	16
62.5	19	20	1.7	10.6	6.9	---	---	.30	19
73.3	10	17	1.6	4.6	6.5	---	---	.09	

TABLE 21.—*Physical and chemical analysis of some representative soils of*

Soil name and sample number	Horizon	Depth	Particle size distribution					
			Gravel (76–2 mm.)	Very coarse sand (2–1 mm.)	Coarse sand (1–0.5 mm.)	Medium sand (0.5–0.25 mm.)	Fine sand (0.25–0.10 mm.)	Very fine sand (0.10–0.05 mm.)
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Chualar sandy loam (62-Calif.-10-13)	A1	0–6	0	10.0	17.7	10.5	18.6	11.7
	B21t	6–25	1.0	10.2	15.6	10.4	9.6	17.2
	B22t	25–38	2.0	9.5	16.6	9.8	16.6	9.5
	C	38–60	6.0	7.9	13.9	10.2	13.9	14.2
Coarsegold fine sandy loam (58-10-3)	A11	0–3	11.1	4.0	4.7	6.8	19.0	20.1
	A12	3–8	8.3	4.8	5.1	5.1	17.8	21.7
	B21t	8–18	6.1	3.5	3.5	5.2	15.3	17.6
	B22t and B2&C	18–32	10.2	2.7	4.0	3.6	14.0	21.0
	C	32	65.2	4.2	4.2	5.8	17.9	32.4
Cometa sandy loam (62 Calif. 10 21)[1]	A11	0–8	3.0	11.0	15.6	10.6	17.0	11.8
	A12	8–12	3.0	12.9	17.4	11.5	12.8	11.7
	A3	12–17	4.0	9.3	15.8	10.6	15.9	12.4
	B2t	17–26	3.0	12.4	11.7	6.7	9.0	3.4
	C	26	9.0	19.5	24.4	12.2	10.2	7.8
Delhi loamy sand (62 Calif. 10 3)[1]	Ap	0–7		2.0	21.2	14.6	22.5	16.6
	C1	7–25		1.8	21.0	15.1	23.1	19.0
	C2	25–60		2.2	22.5	15.8	20.1	18.4
Daulton stony loam (58-10-7)	A1	0–4	30.1	7.9	8.0	8.2	11.2	8.4
	B2t	4–12	47.2	9.1	10.7	7.0	9.0	6.8
	C	12–20	82.9	19.5	14.8	10.2	8.5	4.9
Exeter sandy loam (PS15).	Ap	0–6						
	A3	6–15	---					
	B2t	15–30	---					
Fancher stony loam (60 Calif. 10 4).	A11	0–2						
	A12	2–7	---					
	B1t	7–12	---	---	---	---	---	---
	B2t	12–20	---					
	B3t	20–25	---	---	---			
Fresno fine sandy loam (S58 Calif. 10 1)[1]	A1	0–6		.3	2.9	3.7	13.2	17.4
	B21	6–12		.2	2.0	2.4	9.5	11.2
	B3	12–21		7.6	23.5	3.2	6.9	2.3
	Cmca	21–28						
	C2ca	28–39		8.2	10.8	5.7	15.2	16.2
	IIC3ca	39–63		2.1	3.0	2.3	9.9	18.1
Friant fine sandy loam (62 Calif. 10 30)[1]	A11	0–3	10.0	8.9	9.3	7.8	16.9	32.0
	A12	3–14	5.0	8.4	8.2	7.4	24.2	24.8
Grangeville fine sandy loam (64 Calif.-10-1)	Ap	0–8		.6	1.3	3.0	27.7	24.0
	C1	8–34		.2	.7	2.5	34.5	26.8
	C2	34–60		0	.7	2.2	23.1	24.6
Greenfield sandy loam (PS21)	Ap	0–8	---					
	A1	8–16						
	B21t	16–38						
	B22t	38–50						
Hanford fine sandy loam (62 Calif. 10 5).[1]	Ap1	0–7	---	1.4	11.9	10.0	20.9	16.3
	Ap2	7–16	---	.8	10.0	11.9	16.0	20.3
	C1	16–44	---	.5	9.6	12.6	25.4	14.8
	C2	44–72	---	.6	8.8	13.4	18.2	16.0
Hildreth clay (62 Calif.-10-9)[1]	A1	0–10		1.9	4.5	4.4	8.7	8.6
	C1	10–26		3.6	6.1	4.4	8.6	9.5
	C2	26–46		4.3	4.5	4.7	8.8	9.2
Honcut fine sandy loam (PS35).	A11 and A12	0–12						
	C1	12–30	---		---	---	---	
	C2	30–32						

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Particle-size distribution—Continued: Total sand	Silt (0.05–0.002 mm.)	Clay (less than 0.002 mm.)	Bulk density	Moisture held at tension of 15 atmospheres	Reaction	Calcium carbonate	Phosphate	Organic carbon	Carbon-nitrogen ratio
Percent	Percent	Percent	Gm./cc.	Percent	pH	Percent	P.p.m.	Percent	
68.5	12	20	1.8	5.9	6.1	---	---	1.00	14
63.0	12	25	1.8	7.2	5.9			.81	17
62.0	16	22	2.1	8.9	5.8			.10	10
60.1	23	17	2.0	8.4	6.0	---	---	.05	6
54.6	32	13	1.2	6.0	6.2	---	.13	1.67	11
54.5	30	16	1.7	4.9	6.1		.01	.72	13
45.1	26	29	1.6	8.7	6.3		.02	.57	12
45.3	25	30	2.0+	10.5	6.3	---	0	.39	11
64.5	26	9	---	5.4	7.1	0	.08	.10	11
65.5	25	9	1.9	2.6	6.5	---	---	.29	12
66.3	24	10	1.9	2.8	5.7			.18	11
64.0	24	12	2.0	3.6	6.0			.12	10
42.2	9	49	2.1	15.1	5.9	---		.18	22
74.1	8	18	2.0	9.0	6.5		---	.04	20
76.0	19	4	---	1.3	6.4	---	---	.26	11
80.0	17	3		1.7	6.6			.08	10
79.0	17	4	---	1.4	6.9	---		.07	12
43.7	39	17	1.3	9.5	6.9		.17	1.50	12
41.5	34	24	1.4	10.5	7.0	<1	.09	.42	11
57.0	22	20	---	12.0		---	---	.26	12
60	32	8	1.6		6.9	---			---
50	31	10	1.7		7.1	---	---	---	---
64	32	14	1.8	---	7.4	---			
30.9	57	12		19.2	6.6	---	[1]7.5	6.51	15
32.0	52	16		9.7	6.8		3.6	1.01	15
30.0	49	21		9.4	6.7		2.0	.94	13
24.8	34	41		19.0	6.0		2.3	.54	11
42.2	21	37	---	21.0	6.5	---	1.3	.31	9
37.5	58	8		4.8	8.1	3	---	.45	9
26.3	49	25	---	9.4	8.9	5		.21	7
43.5	46	11		7.4	9.8	8		.18	7
55.1	39	6	---	---	9.1	15	---	.09	---
35.4	61	4		6.0	9.8	14	---	.50	
				4.2	8.9	7	---	.02	
74.9	18	7	1.6	3.4	6.4	---	---	1.34	17
70.0	20	7	1.7	2.0	6.6	---	---	.09	23
56.5	34	9	1.6	4.2	6.7			.75	12
64.7	28	7	1.4	3.4	6.9		---	.30	12
50.6	40	9	1.5	5.0	8.2	<1	---	.04	
76	14	10	[2]1.6		7.2	---			
83	8	9	[2]1.8		6.5				
76	10	14	[2]1.8	---	6.4	---	---		
71	13	16	[2]1.7	---	6.2			---	
60.5	32	8	1.8	2.8	6.4	---		.44	11
59.0	34	7	1.8	2.5	6.5			.22	8
62.9	32	5	1.7	2.0	6.7		---	.10	---
57.0	39	4	1.7	2.0	6.8	---	---	.06	---
28.1	25	47	2.0	16.9	6.2	---	---	.82	14
32.2	24	44	2.0	16.2	6.8			.51	13
31.5	25	43	2.0	15.9	7.6	1	---	.34	13
75	12	10	---	---	6.5	---			
80	10	10	---	---	6.5	---			
80	9	11	---	---	6.7				

TABLE 21.—*Physical and chemical analyses of some representative soils of*

Soil name and sample number	Horizon	Depth	Particle-size distribution					
			Gravel (76-2 mm.)	Very coarse sand (2-1 mm.)	Coarse sand (1-0.5 mm.)	Medium sand (0.5-0.25 mm.)	Fine sand (0.25-0.10 mm.)	Very fine sand (0.10-0.05 mm.)
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Merced clay (58-Calif.-10-3).	Ap	0-4	0	.2	.5	.9	3.7	6.9
	A1	4-12	0	.1	.6	.9	3.7	6.9
	C1	12-46	0	.2	1.0	2.1	7.3	10.0
	C2ca	46-56	0	.8	1.6	2.3	7.0	11.2
	IIC3ca	56-70	4.4	2.3	2.4	2.7	9.1	11.5
	IIC4ca	70	20.0	4.1	4.6	4.2	8.1	9.0
Millerton fine sandy loam (60-Calif.-10-2).	A11	0-2						
	A12	2-9	--			--		
	B2t	9-14	---	---	---	---		
Mt. Olive clay (62-Calif.-10-31)[1]	A11	0-9		2.4	6.3	5.6	2.2	17.0
	A12	9-16		1.9	5.6	6.3	7.4	9.9
	A13	16-25		1.4	5.0	5.1	1.0	16.2
	C1ca	25-35		8.0	9.3	5.8	8.8	10.3
	C2	35-60	--	20.5	17.4	9.2	9.8	17.1
Nord loam (58-Calif.-10-13)	A11	0-5	.6	.6	1.9	3.9	21.4	21.7
	A12	5-15	.2	.3	1.2	3.6	20.2	25.6
	AC	15-19	.7	.5	1.3	3.4	20.3	25.9
	C1ca	19-44	.1	.1	1.0	3.1	18.6	25.1
	IIC2ca	44-56	.2	2.2	4.9	3.3	8.5	9.6
	IIC3ca	56-65	2.4	.4	1.6	3.2	11.4	13.1
Piper sandy loam (58-Calif.-10-7)	A1	0-4	1.5	.9	14.5	10.2	22.1	10.2
	C1ca	4-18	1.0	4.2	22.0	22.2	22.3	8.3
	C2ca	18-36	3.2	2.9	23.2	24.6	23.3	8.7
	C3ca	36-51	3.5	3.5	20.1	24.0	25.0	8.9
	C4ca	51-65	.1	.7	18.0	26.5	29.1	8.4
Pollasky sandy loam (62-Calif.-10-23)[1]	A11	0-3	1.0	10.8	15.0	9.2	13.6	14.3
	A12	3-8	1.0	6.5	11.9	8.4	13.1	20.6
	C1	8-34	1.0	6.6	12.1	7.8	16.4	19.2
	C2	34-39	1.0	6.6	12.3	8.5	12.8	21.1
Pond fine sandy loam (62-Calif.-10-16).[1]	A1	0-3		.5	8.4	13.0	21.9	19.7
	A2ca	3-5	--	.4	9.4	14.6	20.4	10.7
	B1ca	5-8	---	.4	12.0	15.2	21.4	22.2
	B21tca	8-17		.9	9.5	11.1	10.5	24.4
	IIB22tca	17-20		1.4	3.0	3.5	4.3	8.9
	IIIC1	20-35	--	.7	27.0	22.6	22.4	6.2
	IVC2	35		.7	28.3	26.8	21.6	6.6
Porterville clay (62-Calif.-10-6).[1]	A11	0-8		.4	1.7	2.1	6.9	10.0
	A12	8-27		.5	1.4	2.0	6.0	10.9
	C1	27-40	---	1.4	1.9	2.2	7.3	9.9
	C2	40-71	--	.9	2.1	2.6	6.7	8.9
Ramona sandy loam (62-Calif.-10-15)	A11	0-5	3.0	14.8	20.8	11.8	9.1	3.1
	A12	5-12	2.0	12.2	20.7	11.2	10.6	6.8
	B1	12-24	2.0	12.8	21.4	11.3	10.9	6.6
	B2t	24-38	2.0	11.6	19.8	11.4	2.2	14.6
	C	38-78	5.0	24.5	30.0	12.5	10.5	1.9
Redding gravelly loam (62-Calif.-10-7)[1]	A1	0-1	25.9	4.6	7.2	5.2	13.1	13.4
	A3	1-9	9.5	4.9	6.6	5.4	6.9	16.1
	B2t	9-12	1.7	2.3	4.3	2.9	8.6	9.6
	C1m[2]	12-20						
Rossi fine sandy loam (58-Calif.-10-4)	Ap1	0-4	<.1	.4	8.2	13.8	30.1	14.8
	Ap2	4-12	0	.2	5.4	14.0	35.1	13.8
	B21t	12-20	1.9	.2	2.9	5.7	14.5	11.8
	B22tca	20-38	0.5	.6	3.5	4.7	9.7	8.2
	C1ca	38-49	1.6	.9	5.2	5.6	17.5	14.3
	C2	49-53	2.5	.5	3.6	6.4	14.2	8.0
	IIC3	53-65	3.0	.6	15.9	21.9	32.6	10.7
	IIC4	65	<.1	.5	13.2	28.2	44.8	7.5

Eastern Fresno Area, Calif.—Continued

Particle-size distribution—Continued									
Total sand	Silt (0.05–0.002 mm.)	Clay (less than 0.002 mm.)	Bulk density	Moisture held at tension of 15 atmospheres	Reaction	Calcium carbonate	Phosphate	Organic carbon	Carbon nitrogen ratio
Percent	*Percent*	*Percent*	*Gm./cc.*	*Percent*	*pH*	*Percent*	*Ppm.*	*Percent*	
12.2	40	48	1.7	26.2	7.5		2.16	1.45	10
12.2	38	50	1.7	25.0	7.6		2.17	1.59	10
21.6	31	48	2.0	20.2	7.5		.16	.64	11
22.0	37	40	1.9	14.9	7.7	5	.18		
28.0	40	32	1.8	11.8	7.7	9	.08		
30.0	40	30	1.9	8.8	7.9	23	.04		---
68.2	30	7	--	4.6	6.7	---	[b]10.8	1.18	11
65.5	26	9	--	3.9	6.8		15.6	.38	10
60.8	29	10		4.8	7.0		11.7	.32	11
38.5	28	38	1.5	17.4	7.5	11		1.91	14
30.1	30	40	1.5	17.6	7.6	14		1.41	23
28.7	26	46	1.6	11.5	7.6	17		1.38	32
41.3	30	27	1.3	10.1	7.8	46		1.36	
73.8	17	9	1.4	9.4	8.2	27	---	1.10	--
49.4	43	8	1.3	13.0	7.5	<1	3.12	2.88	9
50.9	41	9	1.2	9.2	8.4	2	.58	1.28	10
51.4	41	8	1.2	9.5	8.4	6	.23	.84	10
47.9	44	8	1.4	9.6	9.1	8		.77	14
28.5	43	29	1.3	15.1	8.8	36	.11	.80	13
29.7	40	30	1.2	18.6	9.2	38	.11	.95	15
68.9	17	16	1.6	10.9	8.2	8	1.13	1.61	9
79.0	9	12	1.6	7.4	8.4	11	.28	.17	8
80.7	6	14	1.7	5.1	8.4	10	.11	.13	7
79.5	6	14	1.7	4.5	8.3	15	.06	.19	
80.3	7	13	1.7	4.2	8.4	11	.09		
62.9	26	12	1.6	4.6	6.5			1.47	14
60.5	28	12	1.8	3.4	6.3			.45	10
62.1	26	12	1.7	3.5	6.4			.19	
61.9	28	11	1.8	4.1	7.1	---	--	.11	--
66.5	24	10	1.8	2.3	8.0	<1		.48	12
73.5	18	8	1.8	1.0	9.0	1		.14	
71.2	17	12	1.9	3.0	9.9	1		.17	
55.8	20	24	1.9	8.0	10.2	2		.02	
22.0	51	27	1.6	8.6	10.4	1		.04	
78.9	10	11	1.9	3.3	10.4	<1		.05	
89.0	6	5		1.6	10.5	0		.01	
21.1	27	52	1.9	21.7	6.9	---	---	1.80	14
19.8	28	54	1.9	21.8	7.5	1		.66	18
22.7	24	53	2.0	21.4	7.6	2		.46	18
21.2	27	52		20.6	7.6	3		.31	
59.5	30	10	1.7	3.1	6.4			.94	12
61.5	27	11	1.9	2.5	6.3			.27	11
63.0	24	13	1.9	3.2	6.8			.15	
59.6	10	21	2.0	5.6	6.7			.09	
70.7	4	16	1.9	6.5	7.1	0		.03	
43.8	36	20	1.8	6.6	5.5			2.13	15
41.9	40	18	2.0	5.2	5.4			.43	13
22.7	16	61	1.8	17.3	4.5			.44	10
					6.5				
65.3	19	16	1.5	6.1	7.9	1	1.20	.50	10
68.5	15	16	1.5	5.6	7.9	<1	1.26	.53	12
35.1	35	30	1.9	14.8	9.1	1	5.35	.17	
20.7	42	31	1.7	10.9	10.2	2	4.37	.08	
46.5	37	16	1.8	6.3	10.3	2	1.66	.06	
32.7	45	22	1.8	6.3	10.4	1	1.30		
81.7	9	9	1.7	3.1	10.8	<3	.58	---	
84.2	8	2	1.4	1.8	9.1	---	.23		

TABLE 21.—*Physical and chemical analysis of some representative soils of*

Soil name and sample number	Horizon	Depth	Particle-size distribution					
			Gravel (75-2 mm.)	Very coarse sand (2-1 mm.)	Coarse sand (1-0.5 mm.)	Medium sand (0.5-0.25 mm.)	Fine sand (0.25-0.10 mm.)	Very fine sand (0.10-0.05 mm.)
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
San Joaquin loam (59-Calif. 10-30)	A11	0-2	3.0	7.7	13.6	8.1	11.1	10.0
	A12	2-5	3.0	6.9	12.6	8.5	11.3	10.9
	A3	5-8	3.0	7.7	13.1	8.9	11.6	10.0
	B1	8-16	4.0	8.0	13.0	8.8	10.7	10.4
	B21t	16-25	3.0	6.2	13.7	8.0	11.2	10.6
	B22t	25-28½	2.0					
	IIC1m[3]	28½-36		...				
	IIC2	36	5.0	12.9	20.2	13.3	16.0	19.4
Sesame sandy loam (62-Calif. 10-34).[2]	Ap	0-6	1.0	7.1	11.9	11.2	20.8	16.1
	A3	6-10	1.0	6.1	12.4	9.5	10.6	25.4
	B2t	10-22	2.0	6.4	12.1	9.5	17.1	20.4
	B3	22-30	2.0	6.6	12.0	10.4	21.2	16.7
Sierra sandy loam (62-Calif. 10-32).[2]	A11	0-4	2.0	10.9	10.8	8.1	16.4	8.7
	A12	4-13	2.0	8.5	10.3	8.9	8.1	19.8
	B2t	13-36	6.0	8.7	6.6	5.1	11.1	9.4
	B3t	36-72	8.0	8.5	7.4	6.0	16.0	12.6
Temple clay loam (58-Calif. 10-2)	Ap	0-6	0	.8	2.5	3.9	10.5	20.3
	A3	6-11	0	.4	2.0	4.1	13.2	19.3
	B21gca	11-22	0	.7	3.9	7.2	13.0	23.6
	B22gca	22-31	0	2.2	4.1	5.4	9.5	14.8
	IIC1	31-44	0	.6	12.1	24.0	23.6	7.0
	IIC2g	44-56	0	.5	14.7	29.0	31.1	6.3
	IIIC3	56-68	0	1.2	13.2	31.0	32.8	4.9
Tollhouse coarse sandy loam (54-10-[illegible])	A11	0-11	29.1	19.3	19.1	12.5	16.7	11.3
	A12	11-18	32.6	18.3	13.7	17.0	19.6	10.9
	C&R	18		30.1	18.8	12.1	18.7	9.8
Traver fine sandy loam (62-Calif.-10-17).[2]	A1	0-2	...	3.1	18.5	11.0	18.4	20.2
	A3	2-10		2.9	13.5	10.0	20.0	21.9
	B2t	10-23		4.2	13.3	8.5	13.9	17.0
	C1	23-53		4.1	12.8	9.0	16.5	19.0
	IIC2	53		1.1	1.6	.8	1.1	2.5
Tretten fine sandy loam (62-Calif. 10-25).[2]	A11	0-4	4.0	3.1	5.3	6.0	17.1	27.1
	A12	4-7	3.0	2.6	4.6	5.2	19.5	28.6
	A13	7-13	1.0	2.3	4.4	6.0	20.9	27.1
	B21t	13-29	3.0	2.2	5.4	5.4	21.2	26.9
	B22t	29-36	1.0	2.5	5.0	6.0	20.1	26.5
Trimmer loam (62-Calif. 10-24).[2]	A1	0-5	6.0	4.6	7.5	6.0	16.4	18.8
	A3	5-14	2.0	4.1	6.9	6.0	12.2	21.0
	B21t	14-21	7.0	3.9	6.5	5.8	16.8	18.7
	B22t	21-31	2.0	6.2	9.6	6.8	19.4	22.8
Visalia sandy loam (PS12).	Ap	0-10						
	Ac	10-48						
	C	48-60			...			
Waukena fine sandy loam (58-Calif.-10-6)	A11	0-¾	1.6	.5	7.1	10.5	28.3	19.0
	A12	¾-1¾	.2	.4	6.4	10.6	29.2	21.1
	A13	1¾-4	.1	.6	7.9	12.4	31.1	17.8
	B2tca	4-15	.1	.8	7.9	9.5	21.3	17.1
	IIB3tca	15-19	2.8	4.6	6.7	3.3	7.9	9.3
	IIC1cm	19-37	7.5	1.8	4.8	2.0	7.8	20.2
	IIIC2	37-42	4.4	3.1	20.9	7.3	12.8	23.9
	IIIC3	42-61	1.8	.4	.7	1.7	42.3	39.3
Wisheylu loam (62-Calif. 10-29).[2]	A1	0-4		6.2	8.6	6.0	16.6	15.6
	B1t	4-24		4.9	7.2	5.5	10.8	16.4
	B21t	24-35		3.6	6.0	4.7	12.2	14.2
	B22t	35-40		4.5	7.9	6.5	12.2	10.2
Wunjey silt loam (62-Calif.-10-18).[2]	Ap	0-6	...	1.0	1.2	.9	3.4	17.2
	A1	6-11		.1	.2	.5	6.9	17.7
	C1	11-25		.4	.4	.6	.8	27.0
	C2	25-66		.6	1.1	1.2	6.7	20.1

[2] Analyzed at Davis Soil Morphology Laboratory; all other soils except Fresno soil analyzed at Berkeley Laboratory.
[3] Analyzed at Soil Survey Laboratory, Riverside.

Eastern Fresno Area, Calif.—Continued

Particle-size distribution—Continued									
Total sand	Silt (0.05-0.002 mm.)	Clay (less than 0.002 mm.)	Bulk density	Moisture held at tension of 15 atmospheres	Reaction	Calcium carbonate	Phosphate	Organic carbon	Carbon-nitrogen ratio
Percent	*Percent*	*Percent*	*gm./cc.*	*Percent*	*pH*	*Percent*	*p.p.m.*	*Percent*	
50.6	38	12	1.6	6.2	6.5		53	73	11
50.2	38	12	1.7	5.7	5.9		.16	.59	10
51.3	37	12	1.8	5.2	5.9		.14	.38	9
50.4	35	16	1.6	5.6	6.4		.19	.14	
49.7	31	19	1.9	6.6	6.8		.15	.10	
21	13	66	2.0+	...	...	...	...	...	
74.9	13	11	2.0	4.2	7.2		.07	.05	
67.0	18	15	1.8	6.4	6.4			.60	12
64.0	40	16	2.0	6.6	6.4	...	...	.29	11
65.5	15	19		7.3	6.5		...	.20	
65.2	18	16	1.9	6.9	6.8			.14	
56.9	24	19	1.4	9.6	6.6			2.86	18
55.6	31	23	1.7	8.3	6.3	...		1.21	15
40.9	21	38	1.9	14.4	6.0	...	...	.26	12
40.4	24	37	2.1	11.8	5.8			.17	
38.0	34	28	1.8	12.2	7.4	2	.18	.56	9
39.0	32	29	1.7	11.9	7.5	3	.12	.54	9
48.4	32	20	1.9	8.9	7.8	6	.07	.07	
36.0	32	32	1.9	12.1	8.0	18	.06		
67.9	20	12	1.9	5.3	8.1	2	.11		
81.6	12	6	1.7	2.5	8.4	<1	.09		
83.1	7	10	1.8	5.4	8.2	3	.15		
79.9	9	11		5.3	6.3		.07	1.50	15
79.5	9	11		4.9	6.2	...	.05	1.20	16
89.0	4	7	2.0	3.3	6.0		.02	.24	
66.2	28	6	1.5	2.6	7.4	<1	...	.80	11
67.6	27	6	1.6	1.2	8.6	1		.17	
57.5	21	21	1.8	6.1	9.7	1		.08	
62.3	30	8	1.6	3.0	10.2	<1		.08	
47.1	43	10	1.5	3.9	8.8	9			
58.6	30	11		6.0	6.5			1.64	16
60.5	29	11	1.5	5.8	6.4	...		1.48	10
59.1	30	11	1.7	4.7	6.5			.63	14
61.1	24	15	1.8	5.4	6.6			.27	14
59.1	25	16	2.0	7.2	6.4	...	...	.17	
53.3	35	12	1.6	9.6	6.5			1.07	12
50.8	33	16	1.8	6.6	6.4			.53	16
31.7	43	25	2.0	9.9	6.4			.49	24
64.8	16	19	2.0	8.1	6.2		...	.18	
76	15	9			6.4				
75	14	11		...	6.9	...	...		
70	14	16			7.5	<1			
65.3	26	9	1.4	9.2	7.5		2.17	1.40	8
67.7	24	8	1.5	8.0	8.9	1	1.03	.46	10
69.8	15	15	1.8	4.8	10.4	1	1.25	.12	
56.6	20	23	1.8	10.3	9.2	3	2.35	.05	
32.3	47	21	1.6	9.2	10.4	6	1.28		
45.5	43	11	1.7	6.8	10.3	14	.65		
68.0	25	7	1.7	7.5	9.8	2	.77		
84.4	11	5		3.3	9.5	1	.40		
53.0	35	12	1.8	5.7	6.5			1.42	24
44.8	32	23	1.9	8.4	6.4			.47	11
40.7	26	33	2.0	14.2	6.4			.27	11
47.3	23	30	2.0	14.3	6.7			.18	
23.7	61	15	1.6	8.6	8.8	1	...	.71	12
25.4	61	14	1.4	10.7	8.7	1		.41	11
29.1	57	14	...	8.9	8.0	1	...	.33	14
29.7	61	9	1.4	7.3	8.0	1		.25	17

[1] Indurated hardpan.
[2] Estimated bulk density.

TABLE 22.—*Chemical analyses of selected soils of the Eastern Fresno Area, California*

Soil name (Sample No.)	Horizon	Depth	Extractable cations (Meq. per 100 grams of soil): Calcium	Magnesium	Sodium	Potassium	Cation exchange capacity (Meq. per 100 grams of soil)	Base saturation	Electrical conductivity (ECx10³ millimhos per cm. at 25° C.)
		Inches						*Percent*	
Academy loam (62-Calif.-10-14)	Ap	0-6	5.7	5.2	0.1	0.4	15.5	74	
	B1t	6-12	8.1	6.5	.2	.3	17.3	87	
	B21t	12-20	0.8	8.3	.2	.3	22.0	87	
	B22t	20-30	10.8	8.4	.3	.3	22.0	90	
	C	30	---		.4	.3	16.0	---	--
Aiken loam (62-Calif.-10-35)	A11	0-4	12.6	2.1	.1	1.7	32.8	50	
	A12	4-9	7.5	4.8	.1	1.2	29.8	46	
	B11t	9-21	9.1	1.6	.1	1.1	24.5	48	
	B12t	21-30	6.6	1.6	.1	1.0	19.8	48	
	B21t	30-84	4.9	1.3	.1	.9	13.5	46	
	B22t	84-120	3.0	.9	.1	.8	11.3	42	
Atwater loamy sand (62-Calif.-10-4)	Ap	0-9	1.4	.1	.1	.2	2.5	72	
	A3	9-24	2.4	.3	.1	.2	4.5	67	
	B2t	24-43	2.9	1.0	.1	.2	6.0	67	
	C1	43-60	2.8	.7	.1	.1	4.0	92	
Blasingame loam (60-Calif.-10-1)	A1	0-1	5.7	2.4	.1	.2	12.1	78	
	A3	1-6	6.3	3.6	.1	.2	14.2	77	
	B1	6-10	6.1	4.2	.1	.1	13.8	77	
	B21t	10-26	9.2	6.8	.3	.2	27.5	60	
	B22t	26-32	8.8	6.0	.3	.1	19.5	81	
	C	32	9.5	6.0	.3	.1	19.0	78	
Chino loam (62-Calif.-10-20).	A11	0-3	17.8	4.1	.6	1.7	29.5	82	
	A12	3-12	13.8	2.5	1.0	.4	20.0	88	
	A13	12-18	19.2	4.6	1.6	.3	26.5	97	
	IIC1	18-25	16.1	4.3	1.3	.3	21.8	100	
	IIC2	25-47	7.5	1.7	1.8	.1	10.3	>100	
Chualar sandy loam (62-Calif.-10-13)	A1	0-6	8.5	3.3	.1	.4	15.0	82	
	B21t	6-25	10.5	4.2	.1	.3	18.0	84	
	B22t	25-36	11.3	4.8	.2	.2	20.8	79	
	C	36-53	10.4	4.7	.2	.3	16.8	85	
Cometa sandy loam (62-Calif.-10-21).	A11	0-8	1.8	.9	.1	.2	5.0	60	
	A12	8-12	2.7	.8	.1	.1	5.0	76	
	A3	12-17	3.0	1.1	.2	.1	5.5	80	
	B2t	17-26	14.1	7.1	.7	.2	26.5	83	
	C	36	9.4	4.7	.5	.1	13.2		
Delhi loamy sand (62-Calif.-10-3)	Ap	0-7	2.6	<.1	.1	.4	3.2		
	C1	7-25	1.9	.2	.1	.2	2.0		
	C2	25-60	2.0	.1	.1	.2	4.2	---	---
Fancher stony loam (60-Calif.-10-4).	A11	0-2	10.2	8.8	2.7	1.2	36.2	60	
	A12	2-7	8.6	7.2	2.1	.7	23.8	78	
	B1t	7-12	7.4	9.0	1.6	.6	22.6	82	
	B2t	12-20	3.5	22.0	1.3	.4	33.6	81	---
	B3t	20-25	3.4	27.0	1.3	.3	37.4	85	---
Fresno fine sandy loam (S58-Calif.-10-1)	A1	0-6			3.7	1.3	11.7		1.14
	B21	6-12			14.8	1.4	22.1	---	2.23
	B3	12-21			11.2	1.0	17.5	---	2.20
	C1mca [1]	21-28				---			
	C2ca	28-39			8.4	.1	12.4	---	.91
	IIC3ca	39-63			2.8	.1	10.1	---	.69
Fresant fine sandy loam (62-Calif.-10-30)	A11	0-3	3.5	.6	.1	.5	7.0	71	
	A12	3-14	3.6	.4	.1	.2	6.0	72	
Grangeville fine sandy loam (64-Calif.-10-1).	Ap	0-8	5.8	.5	.1	.6	10.0	70	
	C1	8-34	5.6	.6	.2	.4	11.0	62	
	C2	34-60			.4	.3	14.0		
Hanford fine sandy loam (62-Calif.-10-5)	Ap1	0-7	3.8	.8	.1	.4	5.8	88	
	Ap2	7-16	3.2	.5	.2	.2	4.8	85	
	C1	16-44	3.0	.9	.2	.3	5.2	83	
	C2	44-72	3.3	.3	.2	.1	5.0	96	

TABLE 22.—*Chemical analyses of selected soils of the Eastern Fresno Area, California*—Continued

Soil name (Sample No.)	Horizon	Depth	Extractable cations (Meq. per 100 grams of soil)				Cation exchange capacity (Meq. per 100 grams of soil)	Base saturation	Electrical conductivity (ECx10³ millimhos per cm. at 25° C.)
			Calcium	Magnesium	Sodium	Potassium			
		Inches						*Percent*	
Hildreth clay (62-Calif.-10-9)	A1	0-10	20.1	11.7	.3	.6	34.3	95	
	C1	10-26	21.5	10.4	.6	.4	33.5	98	
	C2	26-46			1.7	.3	31.0		
Mt. Olive clay (62-Calif.-10-31).	A11	0-9		-	.3	1.0	33.5		
	A12	9-16	...	...	.2	.7	31.3		
	A13	16-25			.3	.6	29.8		
	C1ca	25-35					14.8		
	C2	35-60					14.0		
Pollasky sandy loam (62-Calif.-10-23)	A11	0-3	5.2	1.2	.1	.5	8.8	80	
	A12	3-8	4.4	1.2	.1	.2	6.5	91	
	C1	8-34	4.6	1.8	.4	.1	7.8	85	
	C2	34-39	...	...	.3	.1	8.8		
Pond fine sandy loam (62-Calif.-10-16)	A1	0-3			2.6	.5	5.0	...	1.18
	A2ca	3-5			2.6	.2	2.5		2.82
	B1ca	5-8			6.8	.2	10.5		6.1
	B21tca	8-17			16.0	.4	16.5	...	12.5
	IIB22tca	17-20			25.0	.3	17.5		20.5
	IIIC1	20-36			8.6	.1	5.0	...	14.6
	IVC2	36			3.8	.1	8.6		2.22
Porterville clay (62-Calif.-10-15).	A11	0-8	33.6	7.9	.2	.9	44.0		
	A12	8-27	...	...	1.4	.5	40.5		
	C1	27-40			3.2	.4	36.8		
	C2	40-71	...	...	5.7	.3	37.2	...	...
Ramona sandy loam (62-Calif.-10-5).	A11	0-5	4.4	.6	.1	.4	8.0	69	
	A12	5-12	3.0	.4	.1	.2	5.8	64	
	B1	12-24	2.7	.7	.1	.3	5.0	76	
	B2t	24-38	2.8	1.2	.1	.2	7.2	74	
	C	38-72	4.0	1.9	.2	.1	7.0	89	
Redding gravelly loam (62-Calif.-10-7).	A1	0-1	6.0	2.4	.1	.4	14.0	64	
	A3	1-9	5.0	2.4	.1	.2	12.2	63	
	B2t	9-12	13.9	6.9	.4	.3	20.0	98	
	C1m	12-20			...	...	...		
Sesame sandy loam (62-Calif.-10-34)	Ap	0-6	7.6	4.0	.1	.3	14.0	86	
	A3	6-10	8.6	4.5	.1	.3	15.8	86	
	B2t	10-22	11.3	4.6	.1	.3	18.3	89	
	B3	22-30	11.4	4.6	.1	.3	18.5	89	
Sierra sandy loam (62-Calif.-10-32).	A11	0-4	10.9	1.2	.1	.6	16.3	78	
	A12	4-13	7.7	.7	.1	.3	14.3	62	
	B2t	13-36	11.6	3.8	.3	.1	20.5	77	
	B3t	36-72	11.1	4.1	.5	.1	19.9	79	
Travar sandy loam (62-Calif.-10-17)	A1	0-2			.9	.7	6.3		.90
	A2	2-10			1.4	.3	2.5		.84
	B2t	10-23			11.5	1.1	6.8		6.23
	C1	23-53			10.1	.2	6.2		10.4
	IIC2	53			17.4	.2	9.0		5.77
Tretten fine sandy loam (62-Calif.-10-26)	A11	0-4	8.6	.5	.1	.3	13.3	72	
	A12	4-7	8.6	.6	.1	.2	13.3	71	
	A13	7-12	7.1	.4	.1	.2	10.8	72	
	B21t	12-29	6.8	.6	.1	.1	9.7	78	
	B22t	29-36	8.2	1.3	.1	.1	12.8	77	
Trimmer loam (62-Calif.-10-24)	A1	0-5	8.6	1.6	<.1	.3	13.0	81	
	A3	5-14	9.5	1.6	.1	.6	15.5	76	
	B21t	14-21	12.9	1.8	.3	.4	17.8	86	
	B22t	21-31	12.3	2.1	.3	.3	14.5	...	...
Wisheylu loam (62-Calif.-10-29)	A1	0-4	6.4	1.3	.1	.6	12.0	69	
	B1t	4-24	8.4	1.1	.1	.2	15.0	65	
	B21t	24-35	10.2	2.0	.2	.1	18.3	68	
	B22t	35-40	9.7	2.1	.4	.1	17.3	71	

TABLE 22.—*Chemical analyses of selected soils of the Eastern Fresno Area, California*—Continued

Soil name (Sample No.)	Horizon	Depth	Extractable cations (Meq. per 100 grams of soil)				Cation exchange capacity (Meq. per 100 grams of soil)	Base saturation	Electrical conductivity (ECx10³ millimhos per cm. at 25° C.)
			Calcium	Magnesium	Sodium	Potassium			
		Inches						*Percent*	
Wunjey silt loam (62 Calif.-10-18).	Ap	0-6			16.6	5.9	14.8		6.0
	A1	6-11	.		42.8	6.5	14.0	- -	26.0
	C1	11-25			32.2	3.4	11.5		41.0
	C2	25-60			6.3	.9	10.9		8.0
Indurated hardpan									

The amount of clay (particles below 2 microns or 0.002 mm. in size) was determined by the hydrometer method. Fifty grams of soil, together with calgon as a dispersing agent, were shaken overnight in a reciprocating shaker and then transferred to a 1,000-ml. liter cylinder. Hydrometer readings were taken at the proper intervals to record the amount of clay remaining in suspension. The results were expressed as a percentage of the ovendried soil.

The percentage of silt was determined by adding the percentage of sand and the percentage of clay and then subtracting the total from 100 percent.

Bulk density.—For those samples analyzed in the Berkeley laboratory, the bulk density (table 21) was determined by the zinc chloride method. A representative clod of the air-dried soil was given a thin coating of paraffin and then dropped into successive solutions of zinc chloride made up to standard true densities. The lowest density solution in which the lump will float gives the bulk density of the lump of soil.

For those samples analyzed in the Davis Soil Morphology Laboratory, the bulk density was determined by a modified paraffined clod jolly balance method. A representative clod of air-dried soil was weighed, coated with paraffin, reweighed, then weighed in water. The corrected volume of the clod was determined and divided into the air-dry weight of the clod, giving its bulk density.

Moisture retention.—The soil samples were put into small rings on a membrane placed over a porous plate, were saturated with water, and were then placed in the pressure plate apparatus. The desired 15 atmospheres pressure was held for 24 hours under nitrogen gas. The amount of moisture retained was then determined. Moisture retained at 15 atmospheres pressure corresponds fairly close to the permanent wilting point.

Reaction.—The Beckman glass-electrode pH meter was used for the determination of the reaction of each soil shown in table 21. Approximately 50 grams of soil were saturated with distilled water and allowed to stand for 1 hour before the reading was made. A pH value of 7.0 designates a neutral soil. Values decreasing from 7.0 designate increasingly acid soils; values increasing from 7.0 designate increasingly alkaline soils.

Calcium carbonate.—The amount of calcium carbonate (lime), as shown in table 21, was determined on soils having a pH value of more than 7.0. The Williams method was used. A known weight of soil was treated with hydrochloric acid in a sealed jar. The resulting pressure of the carbon dioxide gas produced was measured with a mercury manometer. The manometer was calibrated by measuring the pressure when known amounts of pure calcium carbonate were treated similarly.

Phosphate.—The amount of water-soluble phosphate (table 21) was determined by the modified Bingham method. The soil was extracted with water, and an aliquot of this water extract was tested. Phosphate ion in an acidic solution forms a relatively water-stable complex with a molybdate ion, which in the presence of stannous chloride turns blue. The intensity of the blue color developed is a measure of the amount of phosphate present in the aliquot sample.

Organic carbon.—The total carbon (table 21) was determined by the dry combustion method. A weighed sample of soil was placed in a muffle and ignited at 900° C. in an oxygen stream. Any compound containing carbon was thus oxidized, and the carbon was released as carbon dioxide, which was then absorbed. The increases in weight of the absorbent (ascarite is used) is a direct measure of the carbon dioxide produced. The weight of carbon is converted to the weight of organic matter by multiplying by the factor 1.724. A corrected value for carbon has been reported for soils containing calcium carbonate. The percentage of carbon contributed by the carbonate is subtracted from the value of carbon obtained by the dry combustion method.

Extractable cations.—The extractable cations (table 22) were determined by equilibrating a 10 gram sample of soil with neutral, normal ammonium acetate on a steam bath for 1½ hours and then leaching. Next, the filtrate was analyzed for calcium and magnesium by the EDTA method, and for sodium and potassium by the flame spectrophotometer (10).

Cation exchange capacity.—The cation exchange capacity (table 22) of a soil was determined by the barium chloride triethanolamine method. Four grams of soil were equilibrated with barium chloride triethanolamine on a steam bath for half an hour with frequent stirring. The soil was then filtered and leached until 100 milliliters of the barium solution had passed through the soil. The soil was then dried and shaken with a saturated solution of calcium sulfate. The loss

of calcium from this solution is used as a measure of the cation exchange capacity of the soil. The calcium was determined by EDTA titration (*6*).

Base saturation.—The percentage of base saturation (table 22) was determined by dividing the sum of the extractable cations by the exchange capacity. It was assumed that the contribution from soluble salts was negligible. No attempt was made to evaluate the percentage of base saturation where soils contained carbonates or had electrical conductivity values in excess of 3 millimhos per centimeter at 25° C.

Electrical conductivity.—Electrical conductivity was determined on a saturated soil paste extract using a Wheatstone bridge coupled with a conductivity cell as described in the USDA Handbook 60, Saline and Alkali Soils (*28*). The unit of conductivity is the mho, or the reciprocal of the unit of resistance, the ohm. Conductivity values provide an index measure of the concentration of soluble salts in the extract. This is readily correlated with the amount of salt in the soil and its effect on growing plants. The electrical conductivity is reported in millimhos per centimeter at the standard temperature of 25° C.

Mineralogical Analyses of Clay Fractions

Clay minerals of selected soils of the Eastern Fresno Area were evaluated by the X-ray diffraction technique of M. L. Jackson (*11*) and L. D. Whittig (*34*). The clay minerals indentified in each soil sample are listed in table 23. Quantitative evaluation of the clay minerals is uncertain when using the X-ray diffraction procedure, and therefore, is not given.

The soil samples were treated first with sodium acetate, then hydrogen peroxide, and finally with sodium dithionite to remove the binding agents from the soil. The binding agents would diminish the intensity of the diffracted X-ray beam. The samples were then separated into sand, silt, and clay fractions, and the clay was further separated by centrifuge into 2.0 to 0.2 micron clay particles and clay particles less than 0.2 micron. In the following order magnesium, glycerol (50 percent), potassium, and heating to 500° C. were used as diagnostic tools in evaluating the qualitative nature of the clay minerals present. The X-ray diffraction patterns were evaluated and the clay minerals identified by their characteristic spacing.

General Nature of the Area

This section discusses the physiography, relief, and drainage in the Area, and gives facts about the climate, geology, and natural vegetation. Also discussed are settlement and development, water supply and irrigation, and farming.

Physiography, Relief, and Drainage

The Eastern Fresno Area is partly in the San Joaquin Valley and partly in the western foothills of the Sierra Nevada. The San Joaquin Valley, a great structural downwarp of the earth's surface, is enclosed on all sides by mountains except at the Carquinez Straits, where the Sacramento and San Joaquin Rivers enter the San Francisco Bay. The Sierra Nevada form a barrier on the eastern side of the Valley. The western slope of the Sierra has many deeply incised, southwesterly trending river canyons, fed by many tributaries commonly separated by sharp crested ridges or by broad hilly interfluves.

The foothills.—The Sierra foothills, in the eastern quarter of the Area, range in elevation from about 500 feet at the edge of the valley, to about 4,000 feet near the community of Pinehurst in the southeastern corner of the Area. The general rock types in the Area and the river systems that drain it have generally contributed to the varied, undulating to steep mountainous relief.

The San Joaquin River borders the Area on the north. It has cut a very deep, steep sided canyon, mostly in granitic rock. The Friant Dam, constructed at the mouth of the canyon, impounds the waters of Millerton Lake. Few streams that drain into the river have been able to keep pace with the downcutting of the rivers. Consequently only a few, deep, tributary ravines break up the rolling to hilly soils that make up a large part of the northern part of the foothills. Big Sandy Creek, one of two major tributaries in the Area, drains Big Sandy Valley and the area near Auberry. It joins the river near Temperance Flat. Little Dry Creek, the other major tributary, drains areas of Auberry Valley and Morgan Canyon. Little Dry Creek enters the San Joaquin River a few miles below Friant. Its last mile of flow is through softly consolidated sediment of the terraces.

The Kings River has also cut a deep canyon through the south-central part of the foothills. It drains mainly into the Tulare Lake Basin, but also into the ocean through the Fresno Slough, which joins the San Joaquin River near the town of Mendota. The diversion of water is governed by a control weir at the head of the slough.

The mouth of the Kings River Canyon is northeast of Centerville. This canyon was cut through many kinds of rock. Many deeply incised tributary ravines and valleys and a wide tract of very steep ridges and isolated mountains flank both sides of the canyon. Two of the tributary valleys were cut by Mill Creek and Hughes Creek. Two miles east of their confluence with the Kings River, near Piedra, is the site of the Pine Flat Dam, which impounds the water of the Pine Flat Reservoir. Control of destructive seasonal flooding was achieved through construction of the Pine Flat and Friant Dams.

Between Little Dry Creek and the Kings River, several streams, such as Dry Creek, Dog Creek, Red Bank Slough, and Fancher Creek, drain into the valley, where they disappear before reaching either river. These and other smaller streams formerly were the source of a serious seasonal flooding problem in the metropolitan area of Fresno. Much of the problem has been alleviated by building control structures on Dry Creek and on Red Bank Slough.

Principal streams, such as Holland and Wahtoke

TABLE 23.—*Clay mineralogy analyses of selected soils of the Eastern Fresno Area, Calif.*

[The letter "X" means that the soil has the clay mineral indicated by the column heading; a question mark that the presence of the clay mineral is questionable; and absence of information that the clay mineral is not present]

Soil name and sample number	Horizon	Depth	2.0–0.2 micron clay: Chlorite	Montmorillonite	Vermiculite	Mica	Kaolin	Talc	Analcite	<0.2 micron clay: Interstratified mica-vermiculite	Montmorillonite	Vermiculite	Mica	Kaolin	Analcite
		Inches													
Academy loam (62–Calif.–10–24).	Ap	0–6		X		X	X	X							
	B21t	12–20		X	X	?	X	X							
	C	40		X		X	X								
Cometa sandy loam (62–Calif.–10–21).	A1	0–5		X		X	X								
	A3	12–17		X	X	X	X								
	C	25		X	X	X	X								
Hesperia fine sandy loam (62–Calif.–10–1).	Ap1	0–5		X		X	X								
	Ap2	5–11		X		X	X								
	C1	11–32		X	X	X	X			X					
	C2ca	32–43		X	X	X	X			X					
	IIC3ca	43–63	X	X	X	X	X			X					
	IIC4	63–75	X	X	X	X	X			X					
Hildreth clay (62–Calif.–10–9)	A1	0–10		X	X		X								
	C1	13–26		X	X		X								
	C2	26–46		X	X		X								
Mt. Olive clay (62–Calif.–10–31)	A11	0–9		X	X	X	X				X			X	
	A13	16–25		X	X	X	X			X	X			X	
	C2	35–60		X	X						X			X	
Porterville clay (62–Calif.–10–5)	A11	0–8	X	X			X				X			X	
	A12	8–27	X	X			X				X			X	
	C1	27–40	X	X			X				X			X	
	C2	40–71	X	X			X				X			X	
Traver sandy loam (62–Calif.–10–17).	A1	0–2		X	X	X	X		X						
	B2	10–23		X	X	X	X		X		X	?	X	X	X
	IIC2	55		X	X	X	X								

Creeks, drain into the Kings River southeast of Fancher Creek. Travers, Hill Valley, and Sand Creeks drain and disappear into the valley southeast of Wahtoke Creek. A part of the lower section of the Kaweah River watershed lies south of Pinehurst and Miramonte.

The more gently sloping foothills are on large areas of granitic rock north of the Kings River near Friant, Auberry, and Academy. South of the Kings River, the foothills near Squaw Valley, Dunlap, and Miramonte occur in a stepped manner. Steeper areas occur in the canyon of the San Joaquin River, along Big Sandy Bluffs, near Auberry, and east of Dunlap. The very steep soils near Auberry and Dunlap are, in part, battered fault scarps of a western system of faults in the Sierra in which vertical displacement took place (8). The system of faults also contributed to the change in relief of the lower foothills along the valley land border.

South of the Kings River, the foothills rise very steeply from the valley floor on very rocky slopes. Striking features here are Campbell Mountain, Granite Hill, and Smith Mountain, which are described geologically as fault block outliers.

The relatively level topped mesas, such as Table Mountain and Squaw Leap, lie between Friant and Auberry. These mesas are erosional remnants of an ancient volcanic flow. Other prominent mountains and ridges consist of intrusive basic igneous rocks, metamorphic rocks that have steeply dipping joint or structural planes, and serpentine rocks.

The valley areas.—The valley lands in the Eastern Fresno Area comprise a cross section of a part of the eastside alluvial plains of the San Joaquin Valley. The alluvial materials that formed this gentle landscape were derived entirely from the highlands of the Sierra. Deposition over a long period of time has resulted in differing landforms. The landforms consist of alluvial terraces, young alluvial fans, recent fans, and flood plains.

Terraces occupy much of the eastern part of the valley lands, and erosion has made some of the areas rolling to hilly. The high terraces are minor, though prominent parts of the terraces. They are southeast of Friant and near Centerville, and they represent the remains of extensive fans laid down during the Pliocene and Pleistocene epochs. The high terraces are closely associated with the lower end of the train of basalt-capped mesas and are strongly dissected in the area near Friant. Near Centerville these high terraces are more extensive and have retained some of their original form. Kirkman Hill is the largest remnant at the western end of the high terraces.

The young fans of the San Joaquin and Kings Rivers, and fans of the smaller local streams, are the most extensive of the various landforms. They occupy much of the central part of the valley and in places extend toward the foothills. The very gently sloping young fan of the Kings River extends from the vicinity of Sanger westward to the basin land of the valley trough. This young fan has been cut by four former flood distributaries of the river. These have been partly filled in many places by wind drifted, sandy material that has also extensively modified the surface of this fan. Relief ranges from 10 to 15 feet.

The San Joaquin and Kings Rivers have cut deeply into the young fans and terraces, forming large channels or secondary valleys. These valleys have been incised as much as 60 to 100 feet below the level of the terraces near the foothills. They were not formed by a single episode of downcutting. A remnant sequence of depositional surfaces and erosional surfaces reveals a physiographic history of minor uplifts, or steepening of the stream gradients, interspersed with periods of equilibrium. For a distance of 8 to 10 miles southwest of the boundary of the foothills, these secondary valleys have been widened as much as 3 to 5 miles. Beyond this the valleys narrow to widths ranging from ¼ to ½ mile before disappearing. Recent flood plains and low alluvial benches occupy the floors of these valleys. Where these valleys have terminated downstream, the rivers have formed recent fans that merge with the basin flood plain, the primary drainage axis of the San Joaquin Valley.

The basin flood plain is generally featureless, is nearly level, and occupies the lowest part of the Area. Under natural conditions this physiographic division was mainly a marshy area traversed by many meandering channels and was subject to frequent flooding. The channels have long since been obliterated by leveling. A few low mounds scattered over the area mark remnants of low, natural stream levees along former sloughs.

The general slope of the valley lands is west to southwest. The slope changes abruptly to a northwestern direction on the flood plain of the basin. The gradients range from about 10 to 14 feet per mile on the undissected terraces; from about 4 to 10 feet per mile on the young alluvial fans; and from 5 to 8 feet per mile on the flood plains of rivers in the secondary valleys and on the recent fans of the rivers. The gradient on the flood plain of the basin ranges from nearly level to about 2 feet per mile.

Climate [5]

The Eastern Fresno Area has warm to hot summers and mild winters. Precipitation is fairly light. Winter storms from the Pacific Ocean drop rain in the valley and large amounts of snow in higher areas. The location of the area in the western part of the continent protects it from the temperature extremes common in the middle part of the continent. This insures an equable temperature in the Area which encourages intensive cultivation of specialty crops. The light precipitation, however, makes irrigation essential for most crops.

The increase in elevation in the eastern third of the survey area considerably influences the precipitation pattern. Moist air from the Pacific Ocean comes into the Area over the coast range. Little precipitation falls until the air moves into the Sierra foothills. The amount

[5] By C. Robert Elford, State climatologist for California, Weather Bureau, ESSA, U.S. Department of Commerce.

that falls increases with altitude as the moist air ascends the mountains. It varies, however, according to the aspect of the terrain over which the moisture-bearing winds pass.

In general, temperatures decrease with increase in altitude, though variations occur. The minimum temperature is somewhat warmer, for example, on the eastern parts of the alluvial fans a few hundred feet above the valley trough. As a result crops are not so likely to be damaged by the frost that occasionally damages crops in nearby areas. Also, drainage and trapping of cold air cause the temperature to be abnormally cold at times in low areas.

Temperature.—Temperatures in the Eastern Fresno Area range from hot in summer to moderate in winter. Along the Sierra foothills the minimum temperatures in winter are appreciably warmer than in adjoining areas to the east and to the west. This area consequently is favored by farmers for the growing of crops that are sensitive to frost. It is not, however, without a frost hazard.

The average maximum temperature in July is more than 100° F. near Friant and Clovis and west to the valley trough. In the foothills at elevations of about 2,500 feet, the temperature decreases to the middle eighties or nineties. Temperatures of 100° or more have been recorded at all elevations up to 2,500 feet, and readings of 115° or higher have been recorded at most stations at elevations below about 500 feet. At the Fresno Airport, near the center of the Area, the temperature is 90° or higher on about 101 days each year. The frequency distribution of temperatures in percent, based on a 5-year record of hourly temperatures observed at the Fresno Airport, is given in table 24. For example, this table shows that 0.2 percent of the time in June the temperature ranges from 109° to 105°, but that 14 percent of the time the temperature is in the comfortable range of 74° to 70°.

The average minimum temperature in January is above freezing in most areas at elevations of less than 2,500 feet. It averages about 33° within the trough of the valley. Warmer temperatures occur, however, to the northwest and southeast in a narrow area along the edge of the foothills at elevations of a few hundred feet. In this warmer area frost is a hazard only on the coldest nights, and citrus seldom is damaged by frost. The coldest temperatures occur in areas where cold air collects, such as on the valley floor, where temperatures as low as 10° and 15° have been reported. In these cooler areas severe frost damage is more likely than in the warmer areas near the foothills. Table 25 and figure 10 show further details of temperature.

The average date of the last freezing temperature in spring ranges from near February 1 at lower elevations to the latter part of March at the eastern edge of the survey area. The average date of the first freeze in fall is about November 15 at low elevations and as early as October 15 at the upper edge of the survey area.

The growing season, or the period between the last freezing temperature in spring and the first in fall, varies widely throughout the Area. The number of days between the last temperature of 32° or colder in spring and the first in fall is variable, and that between the last temperature of 28° or colder in spring and the first in fall is also variable. The 32° growing season ranges from 215 to 230 days in the valley, increases to 250 to 300 days along the edge of the foothills, and decreases to 150 to 200 days at an elevation of 2,500 feet. The 28° growing season is about 290 days at the lowest elevations. It ranges from 315 to 350 days in the warmer parts of the Area and drops to as little as 200 to 250 days at the upper edge of the Area. The probability of freezing temperatures is shown in table 26, and the general pattern of distribution of the 32° and 28° growing seasons is shown in figure 10.

Precipitation.—In the Eastern Fresno Area, precipitation in the driest part, toward the west, is about 8 inches per year. It is about 35 inches, however, at the upper end of the Area, toward the east (fig. 11). Average monthly and annual precipitation data for the Area at specified weather stations are given in table 27.

The total annual precipitation varies from year to year. It also varies from place to place, depending upon elevation and exposure to prevailing winds during storms. In 9 years out of 10, 14.41 inches of precipitation can be expected in about the center of the Area, and as much as 36.30 inches can be expected in the southeastern part. On the other hand, in 1 year out of 10 less than 4.10 inches of moisture can be expected in some low parts of the Area and as much as 15.85 inches can be expected in the higher parts. Table 28 gives the probability of receiving total annual precipitation less than indicated for reporting points in and near the Area, and figure 11 shows the amounts to be expected in the Area at specified frequencies.

The average annual snowfall in the Eastern Fresno Area is shown in figure 11. Snow rarely falls in the valley, and only slight amounts of snow fall at lower elevations in the foothills. In these areas the snow melts rapidly and little accumulates on the surface. Nearly 50 inches of snow falls at the highest elevations within the survey area, near Pinehurst. Melting of this snow and of that on higher mountains east of the survey area provide the major source of water for streams flowing into the Area late in spring and in summer.

Nearly 85 percent of the precipitation in the Area falls from October through March. At the lower elevations most of the moisture falls as rain in winter storms that cover the entire Area. Thundershowers of high intensity, but of limited extent, occur in summer on about 5 days each year at lower elevations and on about 8 to 10 days a year at higher elevations. These storms are occasionally accompanied by hail, but the hail does not cause severe crop damage.

The average intensity of precipitation in 1 hour is likely to amount to as much as 0.35 to 0.60 of an inch every other year. The probability is that only once in 100 years will the average intensity of precipitation in 1 hour be as much as 0.90 to 1.50 inches. The average intensity of precipitation in 6 hours ranges from 0.70 to 2.00 inches every 2 years and from 1.75 to 5.00

TABLE 24.—*Frequency distribution of temperature in percent*

[Based on 5-year record of hourly temperatures observed at Fresno Airport]

Temperature	January	February	March	April	May	June	July	August	September	October	November	December
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
109–105						0.3	3.6	0.3	0.1			
104–100					0.3	0.5	8.5	2.1	1.2			
99–95					1.5	2.6	12.1	6.5	3.2	0.8		
94–90				0.5	3.1	6.2	12.2	10.1	6.4	1.3		
89–85				2.1	6.9	7.9	13.1	10.5	9.6	2.4		
84–80			0.4	3.0	8.8	10.8	12.2	12.5	10.6	5.6	0.6	
79–75		[1]	2.2	5.7	10.6	12.8	12.6	12.2	12.3	10.5	2.6	
74–70	0.2	0.9	4.1	8.3	[illegible]	14.0	13.6	13.3	15.8	11.1	6.3	0.2
69–65	.7	3.6	7.6	1.8	13.6	13.2	11.5	14.1	14.6	12.7	7.1	1.0
64–60	2.3	7.1	9.9	4.5	14.3	14.2	5.9	12.8	13.0	12.3	10.1	2.9
59–55	3.1	15.1	12.6	19.1	14.5	12.2	1.5	3.2	12.0	15.4	14.5	9.6
54–50	17.2	15.0	16.6	18.7	9.9	5.4	.1	.4	3.4	14.9	21.5	18.3
49–45	23.3	20.8	21.9	11.1	4.1	.7			.4	8.0	21.2	25.7
44–40	21.9	16.1	15.3	4.2	1.2				.1	2.5	11.8	20.1
39–35	15.0	11.9	7.3	1.6					[1]	.2	4.7	14.0
34–30	6.6	6.1	1.9	.1							1.4	6.7
29–25	1.7	.4	.2								.1	1.4
24–20	[1]											

[1] Less than 0.1 percent.

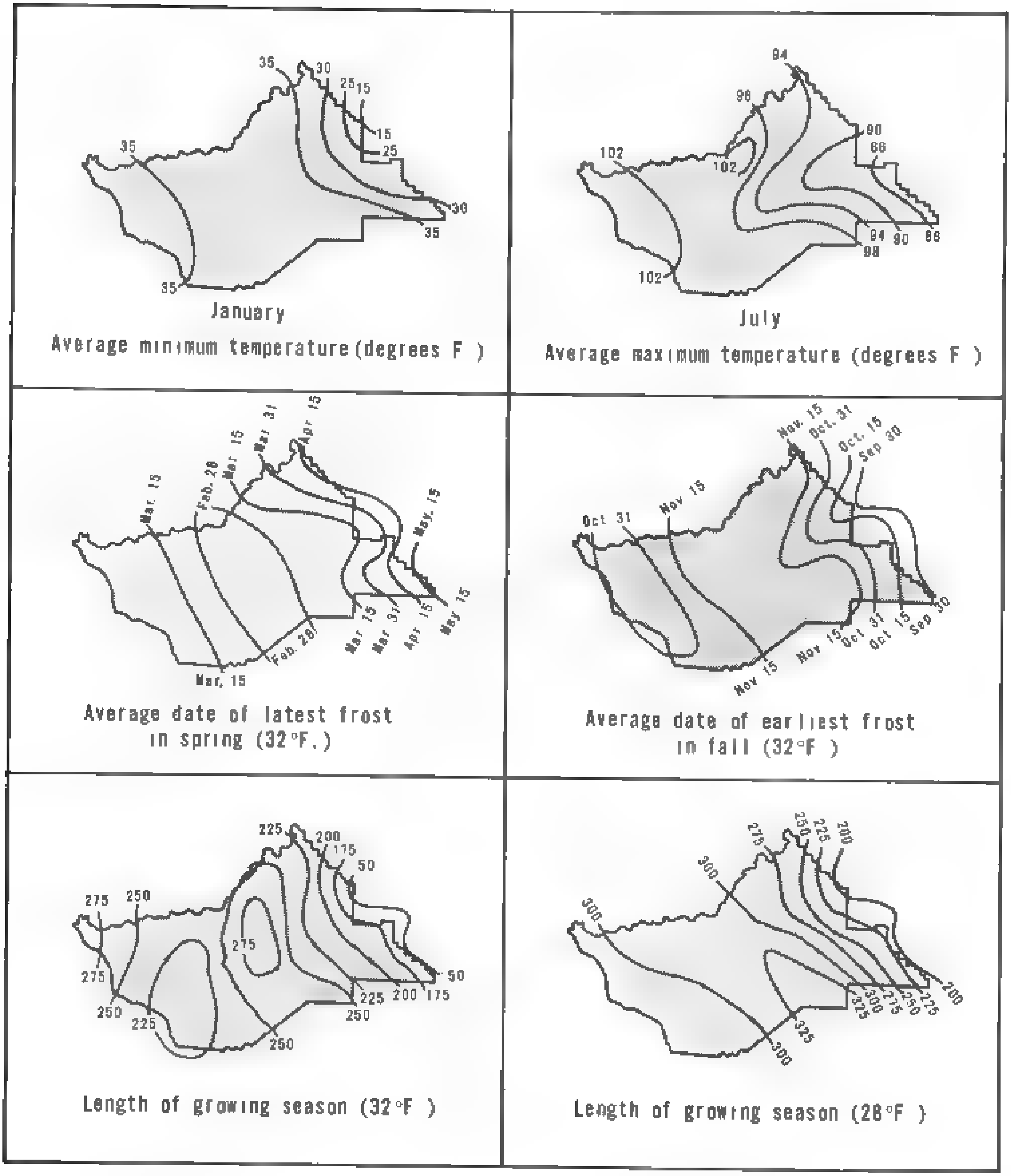

Figure 10.—Temperature, frost data, and length of growing season in Eastern Fresno Area and adjoining areas.

TABLE 25. *Temperature data for seven weather stations in Eastern Fresno Area*

AUBERRY
(Elevation 2,003 feet)

Month	Highest	Mean maximum	Mean	Mean minimum	Lowest
	°F	°F	°F	°F	°F
January	79	55.1	43.1	31.2	11
February	80	57.4	46.0	34.8	18
March	85	61.3	49.5	37.9	20
April	93	68.9	55.3	42.7	22
May	100	78.1	62.8	47.6	26
June	112	87.8	71.5	55.3	20
July	112	95.9	78.9	61.9	42
August	114	94.2	77.4	60.6	38
September	105	87.6	70.9	54.2	33
October	99	76.4	61.1	45.8	22
November	87	65.6	51.1	37.1	19
December	80	57.9	45.6	33.2	14
Annual	114	73.8	59.4	45.2	11

CLOVIS
(Elevation 404 feet)

Month	Highest	Mean maximum	Mean	Mean minimum	Lowest
January	76	55.0	44.7	34.4	15
February	87	61.9	49.7	37.5	18
March	87	68.1	53.8	39.4	24
April	99	72.4	57.9	43.4	26
May	106	85.9	67.3	48.7	32
June	115	94.9	74.9	54.9	39
July	118	102.5	81.2	59.9	42
August	116	100.7	79.7	58.6	41
September	111	93.6	73.5	53.1	35
October	103	81.5	63.9	46.9	26
November	90	67.4	52.6	37.8	22
December	83	56.8	46.1	35.3	18
Annual	118	78.4	62.1	45.8	15

FRESNO
(Elevation 331 feet)

Month	Highest	Mean maximum	Mean	Mean minimum	Lowest
January	79	54.3	45.5	36.7	18
February	80	60.3	49.8	39.2	24
March	89	66.6	54.4	42.1	26
April	97	74.8	60.8	46.8	32
May	108	87.9	67.5	52.0	38
June	110	90.4	73.9	57.4	44
July	111	98.6	80.6	62.6	50
August	110	96.5	78.4	60.3	51
September	111	90.3	73.9	55.9	37
October	100	79.0	64.3	48.7	30
November	89	66.0	53.2	40.4	27
December	76	55.2	46.4	37.6	23
Annual	111	76.4	62.4	48.3	18

FRIANT GOVERNMENT CAMP
(Elevation 410 feet)

Month	Highest	Mean maximum	Mean	Mean minimum	Lowest
January	75	55.8	45.7	35.6	17
February	81	60.6	49.7	38.8	24
March	88	66.2	53.3	40.4	24
April	97	75.3	60.0	44.6	24
May	107	84.5	67.4	50.2	34
June	113	93.2	74.3	55.4	38
July	116	101.5	81.5	61.4	47
August	113	98.8	78.8	58.8	44
September	112	93.5	74.7	55.8	36
October	101	81.5	65.3	49.1	29
November	92	67.8	54.3	40.7	21
December	78	57.5	47.3	37.1	20
Annual	116	78.9	62.7	47.3	17

TABLE 25.—*Temperature data for seven weather stations in Eastern Fresno Area*—Continued

[illegible]
(Elevation 195 feet)

Month	Highest	Mean maximum	Mean	Mean minimum	Lowest
	°F.	°F.	°F.	°F.	°F.
January	75	55.7	44.3	32.8	14
February	87	63.0	48.9	34.8	20
March	87	70.0	54.1	38.3	21
April	98	77.5	60.2	42.9	27
May	109	87.9	68.0	48.1	33
June	113	96.0	75.2	54.4	40
July	119	103.9	81.1	58.3	44
August	117	102.7	79.6	56.6	43
September	109	93.4	72.1	50.3	37
October	102	83.1	62.8	42.5	24
November	89	70.7	51.9	33.1	16
December	75	58.5	46.3	34.1	11
Annual	119	80.2	62.0	43.7	11

ORANGE COVE
(Elevation 431 feet)

Month	Highest	Mean maximum	Mean	Mean minimum	Lowest
January	74	55.7	45.7	35.6	18
February	80	61.3	49.8	38.3	24
March	89	67.4	54.1	40.7	25
April	100	75.7	60.4	45.0	28
May	108	84.2	67.4	50.6	33
June	111	91.4	73.7	56.0	41
July	118	99.3	80.5	61.5	43
August	114	97.2	78.2	59.2	47
September	109	92.0	73.7	55.4	36
October	102	80.0	64.3	47.7	30
November	90	68.0	53.8	39.6	26
December	77	57.2	47.0	36.7	20
Annual	118	77.5	62.4	47.2	18

REEDLEY
(Elevation 347 feet)

Month	Highest	Mean maximum	Mean	Mean minimum	Lowest
January	86	56.6	47.6	37.2	17
February	88	62.4	51.0	38.7	24
March	92	68.0	55.8	42.5	30
April	104	75.8	60.8	45.9	30
May	112	84.4	66.8	49.7	31
June	108	94.2	74.6	54.7	36
July	116	99.5	80.6	61.7	43
August	112	96.8	78.3	58.6	41
September	108	89.5	71.8	53.6	39
October	99	79.0	63.1	47.4	30
November	96	68.0	54.1	40.3	25
December	90	58.2	46.8	36.9	20
Annual	116	77.4	62.6	47.1	17

inches once in a hundred years. In a 24-hour period, an average precipitation of 0.90 to 4.00 inches can be expected every other year, and as much as 2.25 to 10.00 inches can be expected once in a hundred years. The larger amounts are characteristic of areas at the higher elevations.

Soil moisture.—Plant growth is related to the amount of moisture used by a plant. This characteristic provides a convenient basis for computing estimated plant growth in different areas. It is possible to compute the amount of moisture a plant could use under the existing climate if adequate water were available and thus to estimate the potential growth of plants in the particular climate.

In the San Joaquin Valley a plant growing throughout the entire year could make use of about 36 inches of moisture if water were available. Similarly, a plant growing in the southeastern part of the Area, near Miramonte, could use about 25 inches. Plants, such as tomatoes and beans, whose growth is stopped by frost, would not be able to continue their growth throughout the year. If temperatures that stop plant growth are taken into account, the potential use might be limited to around 32 inches in the San Joaquin Valley and to about 20 inches near Miramonte. The values are called potential evapotranspiration (ETp) and potential evapotranspiration for the growing season above 32 degrees (ETp32).

Assuming that the soil is capable of storing 4 inches of available moisture in the root zone, frost-tolerant crops growing the year around with natural rainfall would probably use 7.5 inches at low elevations and as much as 12 inches at the upper end of the Area. More moisture is available to plants during the growing sea-

TABLE 26.—*Probability of temperatures of 32° or colder, and 28° or colder, after specified dates in spring and before specified dates in fall*

Station and season	Temperature	1 year in 10	2 years in 10	3 years in 10	4 years in 10	5 years in 10	6 years in 10	7 years in 10	8 years in 10	9 years in 10	Growing season based on 5 years in 10
	°F										
Auberry											
Spring	28	Mar 26	Mar 19	Mar 16	Mar 11	Mar 8	Mar 5	Mar. 1	Feb. 25	Feb. 18	
Fall	28	Nov 6	Nov. 11	Nov 15	Nov 20	Nov 24	Nov 29	Dec 5	Dec. 20	([1])	261
Spring	32	May 15	May 5	Apr 28	Apr 22	Apr. 16	Apr 10	Apr 5	Mar 28	Mar 18	
Fall	32	Oct. 13	Oct. 22	Oct. 27	Nov 2	Nov 7	Nov 12	Nov 17	Nov 23	Dec. 2	205
Clovis											
Spring	28	-----									
Fall	28										
Spring	32	Apr. 26	Apr 15	Apr 8	Mar 30	Mar 26	Mar. 20	Mar 15	Mar 7	Feb. 23	
Fall	32	Oct. 27	Nov 2	Nov 7	Nov 11	Nov 15	Nov 19	Nov 23	Nov 28	Dec. 4	234
Fresno											
Spring	28	Mar 5	Feb. 22	Feb 15	Feb 7	Feb. 2	Jan 26	Jan. 20	Jan. 11	Jan 1	
Fall	28	Nov 21	Nov 27	Dec 1	Dec 6	Dec. 11	Dec 16	Dec. 24	([1])	([1])	312
Spring	32	Mar. 25	Mar 16	Mar 8	Mar. [illegible]	Feb. 24	Feb. 17	Feb. 9	Jan. 30	Jan. 16	
Fall	32	Oct. 28	Nov 6	Nov 14	Nov 20	Nov 24	Dec 1	Dec. 6	Dec. 13	Dec 22	273
Friant Government Camp											
Spring	28	Apr 5	Mar 25	Mar 17	Mar. 9	Mar 2	Feb. 24	Feb. 17	Feb. 8	Jan. 27	
Fall	28	Nov 16	Nov 22	Nov 28	Dec 3	Dec. 11	([1])	([1])	([1])	([1])	283
Spring	32	May 8	Apr 22	Apr 11	Apr 1	Mar. 24	Mar 16	Mar 6	Feb. 23	Feb 6	
Fall	32	Oct. 24	Nov 3	Nov 11	Nov 17	Nov 28	Nov 30	Dec 6	Dec 14	Dec. 25	244
Helm 5 SE											
Spring	28				--						
Fall	28				--						
Spring	32	Apr. 25	Apr 16	Apr 7	Apr 1	Mar 27	Mar 21	Mar. 16	Mar 8	Feb. 26	
Fall	32	Sept. 27	Oct. 7	Oct. 4	Oct. 2[illegible]	Oct. 26	Nov 1	Nov 6	Nov 13	Nov 23	213
Orange Cove											
Spring	28	Mar 19	Mar 7	Feb 26	Feb. 19	Feb 12	Feb 4	Jan. 26	Jan 16	Jan. 2	
Fall	28	Nov 22	Dec 1	Dec. 8	Dec. 14	Dec 21	Dec. 28	([1])	([1])	([1])	312
Spring	32	Apr. 14	Apr 3	Mar 26	Mar 19	Mar 12	Mar 6	Feb 27	Feb. 19	Feb. 7	
Fall	32	Nov 2	Nov 7	Nov 12	Nov 16	Nov 21	Nov 26	Dec. 1	Dec. 6	Dec. 14	254
Reedley											
Spring	28			--							
Fall	28	--									
Spring	32	Apr 16	Apr 2	Mar 24	Mar 16	Mar 8	Feb. 27	Feb. 20	Feb. 10	Jan. 27	
Fall	32	Nov 6	Nov 12	Nov 16	Nov 19	Nov 22	Nov 25	Nov 29	Dec. 4	([1])	249

[1] Later than December 31.

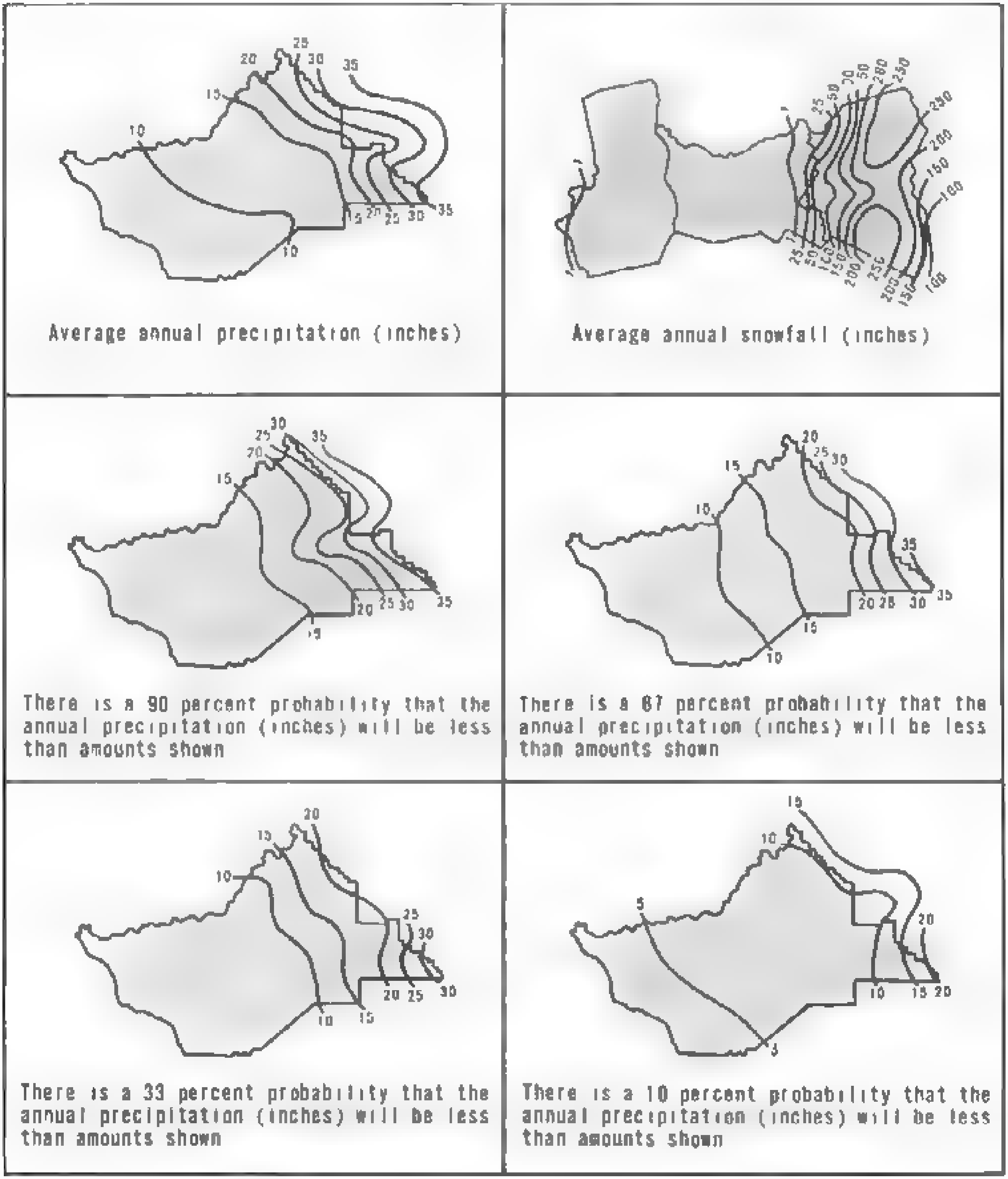

Figure 11.—Precipitation in Eastern Fresno Area and adjoining areas.

TABLE 27.—*Average monthly and annual precipitation at specified stations*

Station	July	August	September	October	November	December	January	February	March	April	May	June	Annual
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Auberry	0 03	0 02	0.29	1.27	2.33	4 17	3.82	5 15	4 19	2.04	0.83	0.12	24 26
Badger	.01	.01	.26	1.08	2.70	4.58	4.54	4.49	4.20	2.75	.94	15	25.71
Clovis	.01	.01	11	74	1 08	2.13	2.17	2.42	2.02	1 03	31	11	12 14
Fresno	(¹)	.01	10	.43	.95	1.97	2.03	2.19	1.96	1.13	30	07	11 14
Friant Government Camp	(¹)	(¹)	.08	.89	1.12	2.65	2.64	2.88	2.71	1.28	26	.03	14.54
Helm 5 SE	(¹)	(¹)	.05	.36	.42	1.65	1.53	1 43	1.19	64	.09	08	7 44
Kingsburg	01	01	15	44	.68	1 45	1.80	1 32	1.52	75	38	10	8.61
Mendota Dam	01	(¹)	10	37	63	1 31	1 47	1 41	1 17	.81	.31	06	7 65
Orange Cove	.01	(¹)	.10	.60	1.11	2.48	2.51	2.51	2.08	1 31	.39	10	13 20
Piedra	02	0	15	79	1.40	3 21	[illegible]	3.24	2.74	1 55	.60	10	17 10
Reedley	02	02	30	59	1 04	1 74	2.47	2.00	[illegible]	90	70	02	11 93
Sanger	.02	01	31	66	97	1 46	2 41	1.65	1.93	.69	.62	09	10 82
Selma	01	(¹)	.27	.48	.87	1.40	1.95	1.45	1.50	75	.43	.04	9.15

¹ Trace.

TABLE 28.—*Probability of receiving less than indicated total annual precipitation*

Station	Probability (percent)								
	5	10	25	33	50	67	75	90	95
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Auberry	13.90	15 80	19 40	20.80	23.90	27 30	29 10	34 40	38.90
Badger	13.76	15 85	19 91	[illegible]	24.90	28.56	30 65	36 30	40.35
Clovis	5.93	7.02	8.50	9.98	11.70	13.65	14 82	18.02	19.97
Fresno	4.33	5.18	6.82	7.53	8.95	10.65	11.64	14.41	16.26
Friant Government Camp	7.01	8.08	10.15	10.94	12.80	14.73	15 87	19.02	21 24
Helm, 5 SE	4.99	5.57	6.64	7 08	7.98	8 96	9.54	11 08	12.09
Kingsburg	4.32	5.09	6.38	6.96	8.11	9.40	10.13	12 19	13.54
Mendota Dam	3.98	4.10	5.74	6.23	7 26	8.36	9.02	11.81	13 04
Orange Cove	6.60	7 71	9.94	10.80	12.72	14 71	15 90	19.24	21 47
Piedra	7 85	9.92	12 40	13 42	15.65	18.04	19.32	23.09	25.74
Reedley	5.70	6.85	8 72	9 70	11 49	13.45	14 60	17 93	20.13
Sanger	4.40	5.41	7.34	8.26	10.00	12.14	13.36	17 03	19 48
Selma	5.04	5.80	7.20	7.74	8.78	10.22	10.98	13.05	14.49

son at high elevations than at low elevations. If only the frost free season is considered, however, the actual plant use is 4.0 to 8.0 inches in the Area. These values are called actual evapotranspiration (4ETa) and actual evapotranspiration for the growing season (4ETa32). The numeral 4 indicates the computations are based on 4 inches of available water capacity in the soil. Some of the significant differences in soil moisture at various places within the Area are shown in table 29 and figure 12. These calculations are based on the Thornthwaite method.

Wind.—At low elevations the direction of the wind tends to parallel the mountain ranges on either side of the San Joaquin Valley. In open areas the prevailing wind blows from the northwest during most of the year, though southeasterly winds are more common during November, December, and January. Wind direction in the foothills is determined primarily by the mountains and may be from almost any direction. The tendency, however, is for the air to move upslope in the middle of the day and downslope at night. Occasionally strong north winds remove moisture from the soil and dry out plants. These winds generally have greater velocity and are more gusty in the western side of the valley than in the eastern.

The strongest winds blow from the southeast in winter and from the northwest the rest of the year. Windspeed is lowest around November and greatest in June.

TABLE 29. *Evapotranspiration, potential (ETp) and actual (ETa), at specified stations*

Station	Annual precipitation	ETp (annual)	ETp32 (growing season)	ETa (annual)	4ETa32 (growing season)
	Inches	*Inches*	*Inches*	*Inches*	*Inches*
Auberry	24.3	32.3	28.0	12.0	7.6
Clovis	12.1	35.2	31 9	10.4	7 0
Fresno	11.1	36.4	35.5	9.3	8.3
Friant Government Camp	14.5	35.9	33.0	10.5	7.6
Helm 5 SE	7.4	35.8	31.8	7.4	4 0
Orange Cove	13.2	35.4	32.5	10.8	7 9

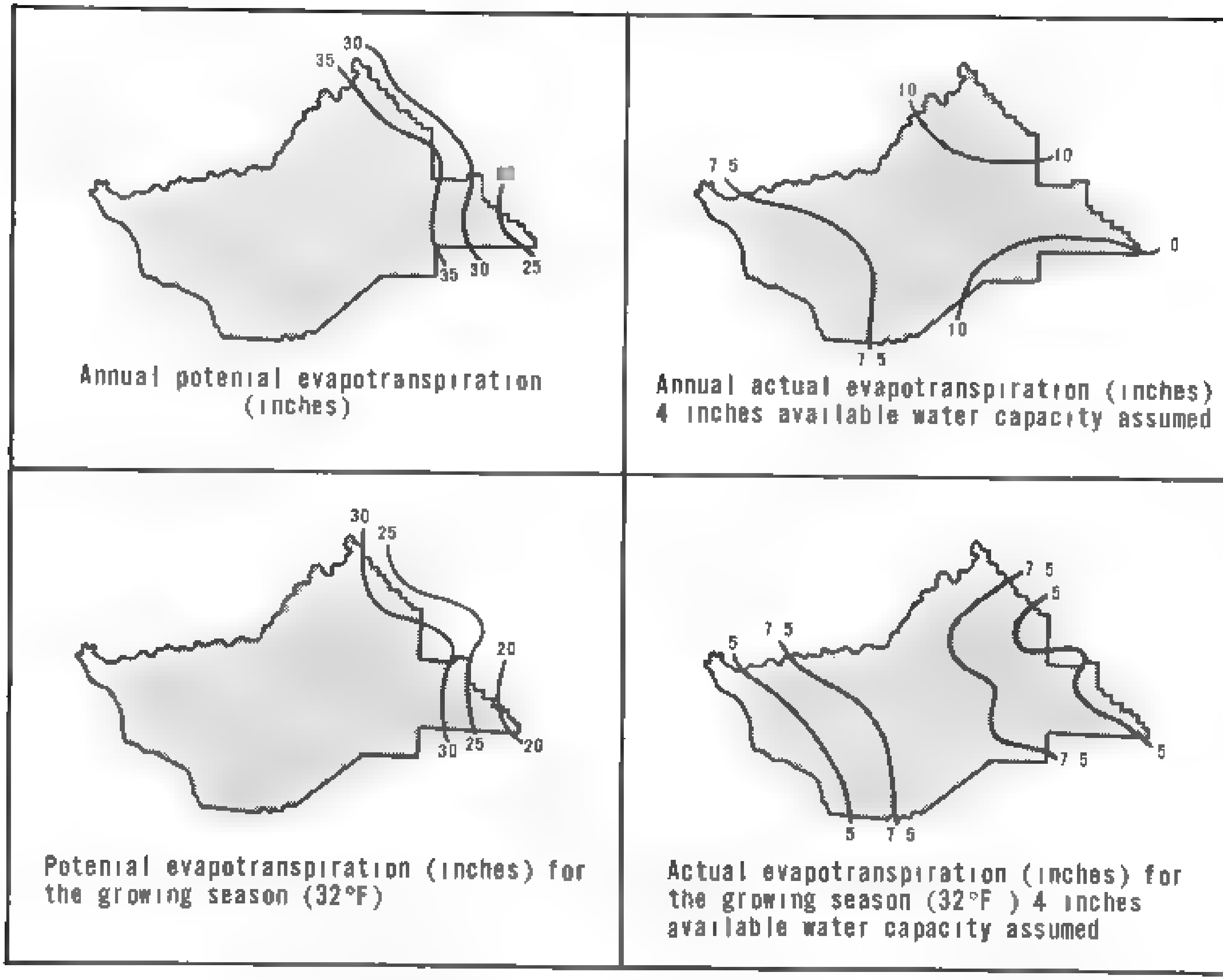

Figure 12.—Potential and actual evapotranspiration in different parts of the Area for the year and for the growing season. The average available water holding capacity is assumed to be 4 inches.

The windspeed reaches 30 miles an hour at low elevations and as much as 50 miles an hour at higher elevations about once every 2 years. Windspeeds of 60 miles to 80 miles an hour occur once in 50 years.

Relative humidity.—In the Eastern Fresno Area relative humidity is fairly high during the winter months, and low during the rest of the year. Late summer and fall are particularly dry in this part of the State. In January relative humidity ranges from around 50 to 70 percent during the day to 90 percent at night. Fog generally forms in the San Joaquin Valley for some periods in winter and may persist for a week or longer

Relative humidity is moderate in spring and fall It commonly ranges from 75 to 85 percent at night and to about 30 percent during the day. Summer and early fall are likely to be very dry Then the average relative humidity is likely to be less than 15 percent in the afternoon and range from 60 to 80 percent at night.

Measurements are not available to determine the effect of irrigation on relative humidity. In areas where regular irrigation is widespread, however, the average relative humidity probably increased in percentage. The demand for irrigation water and the effectiveness of evaporative coolers would be affectd by this modification

Evaporation.—The total annual evaporation from a Class A pan ranges from about 100 inches in the San Joaquin Valley to about 60 or 70 inches at elevations of 2,500 feet. About two-thirds of the annual amount is lost during the months of June through October

Losses during the winter months generally are less than 2 inches in 30 days, but range from as much as 14 to 18 inches in the warmer parts of the Area during a typical summer month.

It is possible that the higher humidity associated with large irrigated areas would result in somewhat lower evaporation values in those areas. Evaporation from lakes is about 75 percent of the Class A pan evaporation.

Sunshine.—At Fresno, records show that during the months of June through September the sun shines more than 95 percent of the daylight hours, but it only shines 45 to 50 percent of the daylight hours during December and January. Cumulus clouds over the foothills reduce the amount of sunshine somewhat in summer. Nevertheless, sunshine is likely to be received for a good part of the day even when such clouds are present.

At Fresno there are 196 clear days, 74 partly cloudy days, and 95 cloudy days in an average year. These figures are representative of conditions throughout the San Joaquin Valley, except that in the summer there are likely to be more clouds in the mountains.

Geology

Geologically, the Eastern Fresno Area is part of the Sierra Nevada and part of the eastside Central Valley. A knowledge of the geology of the Area is helpful in understanding how the soils of the Area developed.

The landforms of the Sierra Nevada and of the eastside plains of the Central Valley are still developing, and many are forming as the result of erosion and deposition. The kind and amount of eroded material depends on the kind and nature of rock in the various parts of the mountains and the history of their uplift. The east side of the Valley receives eroded material from the Sierra. Subsequent minor deformation has resulted in local erosion and rearrangement of some of the eroded material. One of the first detailed and extensive reports of the relationship of landforms and soils in the valley to the geologic history of the Sierra was reported in the soil surveys of Merced and Eastern Stanislaus Areas (*30, 31*).

In late Paleozoic time, more than 200 million years ago, a shallow sea occupied the area of the present Sierra. At about this time, and concurrent with the formation of the Appalachian Mountains in the east there was extensive folding, metamorphism, and uplift of thick sediment and volcanic deposits that had accumulated in the sea. The deposits were derived from a large land mass lying to the west and from submarine volcanism. The uplift formed another great land mass of metamorphic rock that forced the sea to the east. Erosion gradually lowered this surface, and in lower Mesozoic time, many millions of years later, it sank again beneath the sea to be covered by more sediment from the west and by more material from submarine volcanic activity. During this period, large bodies of serpentine were irrupted through the older rocks and into later sediment within the area covered by this survey (*14*). Later metamorphism, uncommon to many areas of serpentine rock elsewhere, enriched these rocks somewhat with calcium-bearing minerals.

Late in Jurassic time, about 135 million years ago, a second great deformation occurred. The younger marine sediment and older rocks were folded, compressed, crumpled, and uplifted to form a great uparched land mass, part of which became the present Sierra. Near the end of the period of folding, small masses of hornblende gabbro and hornblende diorite occurred, and some of these are within the survey area. These basic intrusions were the forerunners of a massive batholithic intrusion of granitic rock within the ancestral Sierra. This intrusion brought large masses of quartz diorite into the crust locally.

Following the emplacement of the basic igneous intrusive masses, the local copper deposits are thought to have formed. This preceded the formation of the mother lode of gold. Late magmatic action from the great batholithic intrusion placed gold in many veins and dikes in the overlying rocks (*14*).

The surface of the land uplifted during late Jurassic time developed many major drainageways consequent to the northwest to southeast trends of the rock folds. Some of the present ridges and a few valleys within the Sierra can trace their existence and orientation to this early drainage pattern. Much of the overlying folded rock was stripped off during Cretaceous time, which exposed extensive areas of quartz diorite locally. Some additional uplift occurred, and elsewhere the remainder of the Sierran batholith was emplaced. The uplift was accompanied by a minor tilting of the land toward the west, and the development of the present westerly drainage pattern was started. A drainage crest was established not far from the present crest of the Sierra.

By early Eocene time, about 60 million years ago, much more of the granitic core of the range had been exposed through erosion. The western and southwestern drainage pattern had become well established, but not in the form seen today. The rivers and streams drained into a shallow sea whose shoreline was not much removed from the present lower edge of the foothills. During Eocene time the sea retreated, but the land surface was further lowered, aided by thorough weathering under a moist, tropical climate. This was followed by a period of renewed stream activity, probably as a result of a slight uplift of tilting. An ancient San Joaquin River carved a broad valley through older rocks and in part removed deposits made during Eocene time.

Somewhat later, probably in the lower Miocene epoch, an eruption of rhyolitic material occurred somewhere in the upper drainage of the old San Joaquin River. The river was overloaded with rhyolitic tuff and pumice, and its lower valley was aggraded, so as to build up a flood plain of this material. Subsequently, two successive flows of basaltic lava poured out from vents somewhere along the river and filled the aggraded river valley downstream, at least as far as the present boundary of the foothills. This forced a relocation of the river course (*14*). The volcanic activity probably coincided with the extensive andesitic flows and tuffaceous deposits that blanketed the central and northern parts of the older Sierra. Except for occasion-

al basalt flows, little evidence is to be found of such extensive activity near the San Joaquin River, or elsewhere in the southern Sierra.

The relocated San Joaquin River, greatly accelerated by later uplifts, cut down and away from its former lava-filled valley. The present chain of basaltic mesas between Auberry and Friant are remnants of this Miocene flow and mark the ancient river channel. They also provide a means of visualizing the great amount of rock worn away in the carving of the present Sierran landscape since Miocene time. The Tertiary history of the Kings River is much more obscure.

The present river canyons were cut following the last great uplift of the Sierra at about the onset of the glacial times near the beginning of the Pleistocene epoch. Glaciation in this part of the Sierra was confined to higher elevations east of the survey area. No glacial activity occurred in the foothills. Outwash material, however, underlies the young alluvial fans, and most of the low river terraces in the valley areas. The outwash material consists mainly of silty rock flour.

The kinds of rock within the foothills reflect the past history of their emplacement and subsequent erosion. The areas of serpentine, gabbro or diorite, metamorphosed intrusive basic igneous rocks, hornblende schist, and quartz mica schist are remnants of deep necks or folds of these older rocks around which quartz diorite was originally emplaced at a great depth. The shape of the present relief is largely controlled by the nature and structure of these rocks.

In the valley lands of the Area, deposition apparently began in about late Pliocene time. Remnants of a few gravelly high terraces are in the Area. Most of these are almost entirely eroded away. The best preserved are the remnants that lie north of Centerville, and adjacent to Tivy Valley on the Kings River. A projection of an old surface level indicates that they were part of a large gravelly fan deposited by the river prior the start of the cutting of its canyon.

The extensive low terraces that merge in many places with the foothills correlate with the Riverbank formation (2), which probably dates from about the middle of the Pleistocene epoch. The San Joaquin hardpan soils generally are on this formation.

The young alluvial fans of the rivers are part of the Modesto formation and are similar to young alluvial fan deposits elsewhere in position, lithology, and soils (2). Hanford soils are typical of soils that formed on this landform. These young fans contain extensive silty substrata and are probably of late Pleistocene time.

The flood plains of the secondary river valleys, the fans disgorging into the valley trough from the lower ends of the secondary valleys, and the basin flood plain are of Recent geologic age. Except for the remnants of old high terraces, all formations related to the two rivers in this Area consist of alluvium derived from granitic rock. Many of the small streams draining the foothills between the rivers have deposited fans and terraces made up of alluvium derived mainly from metamorphic volcanic or basic igneous rock.

In addition to the three major depositional surfaces formed by the rivers, and their small stream counterparts, several intermediate low terrace and alluvial bench levels are present. These reflect a rather complex sequential variation in the erosional and depositional history of the valley areas. Near the secondary valleys cut by the rivers, eight levels of alluvial deposition can be seen, including the three major surfaces. Associated with these are seven distinct erosional surfaces.

Natural Vegetation

The valley areas are mostly cultivated and support a variety of crops under irrigation. Some natural vegetation remains on the terraces, along strips of riparian lands, and in unreclaimed areas of saline-alkali soils. In the foothills the vegetation ranges from open areas of annual grasses to dense areas of trees and shrubs or chaparral. During the dry season, in summer and early in fall, the hazard of fire in the foothills is serious. Consequently fire lookout and control stations are maintained here during the fire season by the California State Division of Forestry. Much of the native vegetation in the Area has been replaced by introduced species or has been eliminated by cultivation and grazing.

Vegetation in the valley areas.—The valley lands originally supported large herds of elk, antelope, and wild horses that grazed mainly on native grasses. Even as early as 1844 filaree (*Erodium cicutarium*), an introduced forb from the Mediterranean region was noted in the stands (11). Marshes occupying the valley trough supported large areas of bulrush or tule (*Scirpus acutus*) and cattail (*Typha* sp.). Trees and shrubs grew along many of the streams and rivers, as they do today. The Fremont cottonwood (*Populus fremontii*), willow (*Salix* sp.), western sycamore (*Platanus racemosa*), wild rose (*Rosa* sp.), California blackberry (*Rubus vitifolius*), and valley oak (*Quercus lobata*).

On the uncultivated terraces, the present herbage consists mainly of red brome (*Bromus rubens*), soft chess (*Bromus mollis*), foxtail (*Festuca megalura*), and filaree. Burclover (*Medicago hispida*) and wild oats (*Avena barbata*) grow in places on the finer textured soils in years when the supply of moisture is favorable. Many forbs, including such wild flowers as California poppy (*Eschscholtzia californica*), blue lupine (*Lupinus* sp.), brodiaea (*Brodiaea* sp.), and buttercups (*Ranunculus californicus*) are conspicuous in spring.

The natural cover of the unreclaimed saline-alkali soils consists of poor stands of red brome, soft chess and foxtail, and of plants that tolerate salts and alkali. Among the plants that tolerate salts and alkali are saltgrass (*Distichlis spicata*), spikeweed (*Centromadia pungens*), alkali mallow (*Sida hederacea*), alkali heath (*Frankenia grandifolia*), and alkali blite (*Suaeda fruticosa*). Pickleweed (*Salicornia pacifica*) and bush pickleweed (*Allenrolfea occidentalis*) grow in places.

Weeds are a serious problem in many cultivated areas. Bermudagrass (*Cynodon dactylon*) provides good forage in irrigated pastures and makes a durable lawn in this climate, but it is a pest in fields of row crops and in flower gardens. Johnsongrass (*Sorghum halepense*) is a nuisance, particularly in areas on the river bottoms and in the vineyards and cottonfields on the young alluvial fans. Other pests are star thistle (*Centaurea solstitialis*), puncturevine (*Tribulus terrestris*), particularly along the shoulders of roads in sandy soils, sandbur (*Cenchrus pauciflorus*), Russian thistle (*Salsola kali* var. *tenuifolia*), mustard (*Brassica* sp.), and fiddleneck (*Amsinckia* sp.). These weeds can be controlled in places by cultivation, and in others, more effectively by weed killers. Tule and cattails cause trouble in ricefields and in places along irrigation and drainage ditches. The Fresno County Agricultural Commissioner can be consulted for help in the control of weeds. Information also is available from the office of the Fresno County Farm Advisor.

Vegetation in the foothills.—In the foothills the vegetation ranges from open annual grasses at low elevations, where rainfall is fairly low, to trees and grass or trees and shrubs at high elevations, where rainfall is higher. The annual grassy vegetation is similar to that on the terraces that are not cultivated. Filaree and soft chess are dominant. Ripgut (*Bromus rigidus*) is common in places. In protected places a few clusters of perennial grasses such as needlegrass (*Stipa* sp.) grow. Burclover and wild oats are abundant, particularly on the finer textured soils.

The principal trees in the wooded areas are blue oak (*Quercus douglassii*), interior live oak (*Quercus wislizenii*), and California buckeye (*Aesculus californica*). Digger pine (*Pinus sabiniana*) is common north of the Kings River, but only a few single trees grow along part of the south shore of Pine Flat Reservoir and none grow south of the river. The main trees at higher elevations are canyon live oak (*Quercus chrysolepis*) and black oak (*Quercus kelloggii*) oracle oak (*Quercus morehus*) grow in a few places. Islands of commercial conifers, mainly ponderosa pine (*Pinus ponderosa*), but that include some incense-cedar (*Libocedrus decurrens*), are near Miramonte. Cottonwoods, sycamores, alders (*Alnus* sp.), and willows grow along many of the streams.

The shrub or chapparral cover consists mainly of wedgeleaf ceanothus (*Ceanothus cuneatus*), chaparral whitethorn (*Ceanothus leucodermis*), mariposa manzanita (*Arctostaphylos mariposa*), birchleaf mountain-mahogany (*Cercocarpus betuloides*), poison oak (*Toxicodendron diversilobum*), California redbud (*Cercis occidentalis*), and California yerba santa (*Eriodictyon californicum*). A rare endemic shrub, California Carpenteria (*Carpenteria californica*) grows on the east slope of Black Mountain near Auberry.

Settlement and Development

Tribes of Yokut Indians lived in the Area long before settlers, explorers, and miners arrived. Campsites used by the Indians are still recognized by the dark surface of the midden areas, the scatterings of shells and chips of obsidian, and an occasional arrowhead. Fresno County was formed in 1856 from parts of Merced and Mariposa Counties. The present boundaries were established in 1909. The name Fresno means "ash tree" in Spanish, and was originally given to Fresno City, a small settlement on the Butterfield stage route near the Fresno Slough.

Lieutenant Gabriel Moraga, the earliest known explorer in the Area, led an expedition in 1805 in search of sites for missions. John C. Fremont explored the Area in 1844.

Settlement accelerated at the time of the gold rush. Mining continued in the county into the early 1860's. Then stock raising was dominant until the 1870's. After the railroad was extended to the county many engaged in general farming. Later, because of the low rainfall in the area, canals were constructed to obtain water from the Kings River. Thus irrigated farming developed.

In 1880 the population of Fresno County was 9,478. By 1962, the population reached 387,400 and the California State Department of Finance estimates that it will reach 613,500 by 1980.

The most important industry in the Eastern Fresno Area is food processing. The principal processed foods are raisins, dried peaches and figs, packed meats, poultry, dairy products, olives, sugar from sugar beets, and a wide variety of canned and frozen fruits, juices, and vegetables. Wines and brandies are also produced. Other major industries in the Area produce lumber and wood products, machinery, chemicals, and petroleum. In addition large printing and publishing firms and commercial sand and gravel operations are in the Area, as well as miscellaneous manufacturing plants.

Main lines of both the Santa Fe and Southern Pacific Railroads cross the Area, and branch and spur lines also serve many communities and industries. Large marshalling and switching yards that have siding capacity of 6,300 railroad cars, including refrigerated cars, are located in Fresno.

Fresno County is served by Federal, State, and County highways. About half of the State highway mileage, and more than 80 percent of the county road system is in the survey area. Good to excellent farm to market roads are provided. United States Highway No. 99, a limited access freeway, crosses the county from north to south. State routes 41, 168, and 180 cross the county and provide access to the timber and recreation areas north any east of the survey area.

The Area is served by two major buslines. Twenty-one major trucklines provide local and long distance hauling.

Scheduled air freight and passenger travel is provided by Hammer Field, a major airport. Two smaller municipal airports and several public and private landing strips also serve the Area.

The Eastern Fresno Area is well supplied with facilities for education, health, public utilities, communication, recreation, public safety, property protection, and public service. Elementary and secondary

schools serve all parts of the county. Two Junior Colleges, Fresno City College, and Reedley College are located in the city of Fresno, and the California State College at Fresno and its large agricultural school is located nearby. Many private, trade, and professional schools are located in the Fresno metropolitan area.

Medical facilities in the area include five hospitals, which in turn, include a veterans hospital, a county hospital, a tuberculosis sanitarium, and an outpatient clinic. Many private clinics also serve the area.

Electricity and natural gas are supplied to nearly all parts of the area. Bottled gas or liquid petroleum gas is available through private companies. Telephone service, and in places radio-telephone service, is supplied to most of the county.

Outdoor and indoor recreational facilities are plentiful in the Area and nearby. A convention center in the city of Fresno provides facilities for many groups throughout the county.

Public safety, traffic control, and protection of property is provided in each incorporated city or town in the Area by police and fire departments. The rural areas and unincorporated towns are under the jurisdiction of the county sheriff's office.

Water Supply and Irrigation

Water of generally good to excellent quality is available to the Eastern Fresno Area from streams, rivers, reservoirs, springs, and rainfall. The natural source is runoff or accumulation of rainfall and snowfall from the Sierra. Winter accumulation of snow in the higher mountains provides a seasonal reservoir of water. The water flows to the area mainly through the Kings and San Joaquin Rivers. The peak period of flow generally is in May or June. The Kings River supplies nearly all of the surface water used for irrigation and much of the ground water pumped for irrigation and for domestic and industrial use. The San Joaquin River mainly replenishes the supply of ground water used in the northern part of the Area.

Much of the water from Millerton lake is diverted to the southern part of the San Joaquin Valley through the Friant Kern Canal. This canal runs along the eastern edge of the valley and is siphoned under the major rivers and larger streams. A relatively small amount of this water is diverted from the canal for the use of two irrigation districts in the survey area.

The construction of the Friant and Pine Flat Dams and other dams upstream, on both the Kings and San Joaquin Rivers, has helped to control flooding. The dams also help to regulate the use of surface and ground water. This is necessary because much farming in this Area is done under irrigation.

A ground water reservoir, through pumping, supplies needed water during seasonal periods of low surface water flow or during years of unfavorable precipitation. The ground water is replenished by local rainfall, by infiltration from streams, from unlined canals, ditches, and ponds, by excess irrigation water, and by underflow through permeable materials in stream canyons (7). Development of new cropland, increase in population, and new industry may make it necessary to import additional water from the California Water System.

Efforts to develop a surface irrigation system for the Area were started as early as 1860. The early works were destroyed, however, by the flood of 1867-68. Later in 1868, the Centerville Ditch was constructed along the Hazelton Channel to irrigate the territory around Centerville. The Sween Ditch, started in 1867, later was extended and became the Easterby Canal, which in turn, became the Fresno Canal and Irrigation Company. This company became the present Fresno Irrigation District.

In the late 70's and early 80's many canals were constructed. The development of the canal system resulted in the voluntary establishment of the Kings River Water Users Association in 1918. Principal irrigation districts now distributing water from the Kings River are: (1) the Fresno, (2) the Consolidated, (3) the Alta, (4) the Laguna, (5) the Riverdale, and (6) the James. There are also a few smaller districts.

In the foothills, water is obtained from perennial and seasonally intermittent streams, from springs, and from shallow wells in pockets of alluvium or deeply weathered rock. Special spoke wells, which have several lateral borings from the principal boring, are successful at times in intercepting water seepage along certain breaks or fractures in the rock. Earthen dams have been constructed throughout the foothills to intercept and impound water for stock or for recreational use, and in a few places sufficient water is available to permit establishment of irrigated pasture or to allow irrigation for apple orchards at higher elevations.

Irrigation methods in general use in Eastern Fresno Area are check flooding of the surface, between contour or graded checks; furrow, which often results in wetting only part of the surface; and sprinkling, which wets the whole surface in a manner similar to rainfall.

Alfalfa, grain, and pasture generally are irrigated by flooding between border checks. Rice is flooded between contour checks. Such row crops as cotton, sugar beets, grain sorghum, and corn are irrigated by use of the furrow method. In addition the furrow method is used for truck crops and for some vineyards and orchards. In some orchards and vineyards a combination of furrow and basin checks is used to get deep soaking of the water. Overhead sprinkling is used in many areas. It is particularly suited to field crops on soils that are too steep or shallow, or on sandy soils that have a high infiltration rate (fig. 13). Low set, low volume sprinklers are used in some orchards, particularly in citrus, where sprinkling can also, under certain conditions, offer some frost protection.

Farming

The combination of good soils, a plentiful supply of water for irrigation, and the long growing season have made possible the development of highly specialized, intensive farming and the growing of a wide

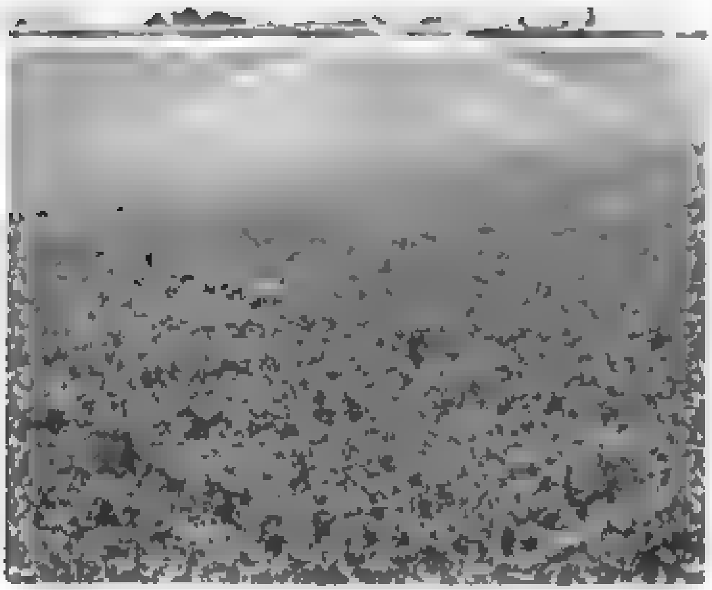

Figure 13.—Sprinkler irrigation of alfalfa on sandy Delhi soils.

variety of crops. The management practices used are outlined in the section of "Yield Predictions and Management Practices."

Table 30 shows the acreage of the principal crops harvested in Fresno County in 1964, and the numbers of grapevines and fruit and nut trees. The principal kinds and numbers of livestock in Fresno County in 1964 are shown in table 31. The statistics are mainly from the 1964 U.S. Census of Agriculture.

It must be anticipated that the practices outlined in this survey will be replaced or modified as the knowledge of crops, soils, and plant nutrition increases. Current crop, livestock, and farm management information can be obtained from the University of California Agriculture Extension Service, represented by the Fresno County Farm and Home Advisors Office, and from the Soil Conservation Service, U.S. Department of Agriculture.

Certified and common seed crops grown in Fresno County include many strains of alfalfa, pasture grasses, field crops, vegetable crops, and cereal grains. Vegetable crops grown in the county include beans, cabbage, sweet corn, Chinese vegetables, cucumbers, melons, onions, potatoes, radishes, romaine, squash, sweet potatoes, tomatoes, and turnips. Nursery products include a wide variety of landscaping plants and trees for deciduous and citrus orchards and grapevines. Much of the income in the county comes from field crops and fruit and nut crops.

Crops are distributed throughout the Eastern Fresno Area in a broad pattern. Fruit and nut crops are grown mainly on the upper parts of the young alluvial fans, on better drained parts of the recent flood plains and fans along rivers and other streams,

TABLE 30.—*Acreage of crops in 1964*

Crops	Acres
Barley	202,122
Corn (grain)	5,757
Corn (silage)	6,013
Cotton	190,184
Alfalfa	104,490
Oats	924
Irrigated pasture	43,687
Rice	16,177
Strawberries	2[illegible]0
Safflower	86,867
Sorghum (all purposes)	15,084
Sorghum grain	[illegible]
Sugar beets	28,973
Wheat	13,360
Fruit trees of all ages:	*Numbers*
Apricots	39,509
Figs	740,901
Lemons	23,178
Nectarines	524,058
Olives	38,106
Oranges	
Navel	990,137
Valencia	229,094
Peaches	
Freestone	1,070,956
Clingstone	309,638
Plums	846,605
Prunes	54,165
Grapevines:	
Raisin	74,437,047
Table	7,1[illegible]0,424
Wine or juice	9,100,479
Nut trees of all ages:	
Almond	462,019
Walnut (English)	88,981

TABLE 31.—*Number of livestock on farms in 1964*

Livestock	Number
Cattle and calves	256,834
Milk cows	88,309
Hogs and pigs	7,005
Sheep and lambs	12[illegible],667
Chickens [1]	[illegible]
Turkeys	2,130,867

[1] 4 months old and older

and on a large portion of the low alluvial terraces near Clovis, Fresno, Orange Cove, Reedley, and Sanger. The low terraces are used mainly for range or for dryfarmed field crops near Academy, Pinedale, and Round Mountain. The vegetable crops, and small areas that produce nursery stock, are on the deep, well-drained soils of the young and recent alluvial fans or flood plains. Most of the seed crops are grown on the basin flood plains. Field crops are intermingled, in places, with the fruit and nut crops. They are dominant on the lower parts of the young alluvial fans of both rivers, and are pioneering on reclaimed soils of the basin rim. They also are grown in large areas on the basin flood plain. Except in a few small valleys and in selected, specialized areas along their lower margins, cultivated crops are not grown in the foothills.

Table 32 shows the trend is toward larger farms. Small farms are being consolidated to form a larger unit or are being converted to residential subdivisions.

Bees, both domestic and wild, are needed in the Area for pollinating crops. Apiarists contract with farmers to keep beehives near specified crops.

TABLE 32.—*Farm sizes in Fresno County, California, in 1959 and 1964*

Acres	Number of farms	
	1959	1964
Under 10	813	[illegible]
10–49	4,321	[illegible]
50–69	691	683
70–99	685	650
100–139	429	445
140–179	288	251
180–219	[illegible]	[illegible]
220–259	119	[illegible]
260–499	292	[illegible]
500–999	219	[illegible]
1,000 and over	345	320
Total	8,345	7,204

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Glossary

Acidity. See Reaction, soil.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvial fan. A fan-shaped deposit of sand, gravel, and fine material dropped by a stream where its gradient lessens abruptly.

Alkali soil. Generally, a strongly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Soil material, such as sand, silt, or clay that has been deposited on land by streams.

Available water holding capacity (also termed available moisture holding capacity). The difference between the amount of water in the soil at field capacity and the amount in the same soil at the permanent wilting point of plants. Commonly expressed as inches of water per inch depth of soil.

Base saturation. The degree to which material that has base exchange properties is saturated with exchangeable cations other than hydrogen, expressed as a percentage of the cation exchange capacity.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Chiseling. Loosening the soil, without inversion and with a minimum of mixing of the surface soil, to shatter material below normal plow depth that restricts movement of water or development of roots.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Claypan. A compact, very slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly very hard when dry and very plastic or very sticky when wet.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a publishable soil map.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent, does not hold together in a mass when dry or moist.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening. A *weakly cemented* mass is brittle and hard, but it can be broken in the hands. A *strongly cemented* mass is brittle, it is too hard to be broken in the hand but can easily be broken with a hammer. An *indurated* mass is very strongly cemented and brittle, does not soften under prolonged wetting, and a sharp blow with a hammer is required to break it.

Drainage, natural. Refers to moisture conditions that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural drainage are recognized.

Excessively drained soils are commonly very porous and very rapidly permeable and have low water holding capacity.

Somewhat excessively drained soils are rapidly permeable and are free from mottling throughout the profile.

Well drained soils are typically free from mottling, moderately permeable, and commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the surface soil and in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and many soils commonly have mottlings below 6 to 16 inches in the lower part of the A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Eluviation. The movement of material from one place to another within the soil, either in true solution or in colloidal suspension. Soil horizons that have lost material through eluviation are said to be eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants when other growth factors, such as light, moisture, temperature, and the physical condition of the soil are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Flood plain. Nearly level land, consisting of stream sediment, that borders a stream and is subject to flooding unless protected artificially.

Fragipan. A loamy, brittle subsurface horizon that is very low in organic matter and clay but is rich in silt or very fine sand. The layer is seemingly cemented. When dry, it is hard or very hard and has a high bulk density in comparison with the horizon or horizons above it. When moist, the fragipan tends to rupture suddenly if pressure is applied, rather than to deform slowly. The layer is generally mottled, is slowly or very slowly permeable to water, and has few or many

bleached fracture planes that form polygons. Fragipans are a few inches to several feet thick; they generally occur below the B horizon, 15 to 40 inches below the surface.

Gleyed soil. A soil in which waterlogging and lack of oxygen have caused the material in one or more horizons to be neutral gray in color. The term "gleyed" is applied to soil horizons with yellow and gray mottling caused by intermittent waterlogging.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material may be sandy or clayey, and it may be cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused by (1) accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of 1, 2, and 3. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Humus. The well-decomposed, more or less stable part of the organic matter in mineral soils.

Igneous rock. A rock produced through the cooling of melted mineral material. Examples: Granite, andesite, diorite, and basalt.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to relatively level plots surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops, or in orchards, to confine the flow of water to one direction.

Furrow.—Water is applied in small ditches made by cultivation implements used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Irrigation water, released at high points, flows onto the field without controlled distribution.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Lime. Chemically, lime is calcium oxide (CaO), but as the term is commonly used, it is also calcium carbonate ($CaCO_3$), and calcium hydroxide ($Ca(OH)_2$). Agricultural lime refers to ground limestone, hydrated lime, or burned lime, with or without magnesium minerals. Basic slag, oystershells, and marl also contain calcium.

Loam. Soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Metamorphic rocks. Rocks of any origin that have been completely changed physically by pressure, heat and movement. Such rocks are nearly always crystalline. Examples: Mica schist and serpentine.

Microrelief. Minor surface irregularities of the land, such as low mounds or shallow pits. Some of these are termed hog-wallow microrelief.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soil usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance— *few*, *common*, and *many*; size— *fine*, *medium*, and *coarse*; and contrast— *faint*, *distinct*, and *prominent*. The size measurements are these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Neutral soil. In practice, a soil having a pH value between 6.6 and 7.3; strictly speaking, a soil that has a pH value of 7.0.

Parent material (soil). The horizon of weathered rock or partly weathered material from which the soil formed; horizon C in the soil profile.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *very slow*, *slow*, *moderately slow*, *moderate*, *moderately rapid*, *rapid*, and *very rapid*.

Plowpan. A compacted layer formed in the soil immediately below the plowed layer.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		pH
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Root zone. The part of the soil that is penetrated, or can be penetrated, by plant roots.

Runoff. The rate at which water is removed by flow over the surface of the soil. Relative terms are *very rapid*, *rapid*, *medium*, *slow*, *very slow*, and *ponded*.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Sedimentary rock. A rock largely composed of particles deposited from suspension in water.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the materials in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand), or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. See Chiseling.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt loam*, *silt*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and the soil series to which the mapping unit belongs. In referring to a capability unit or a range site, read the introduction to the section it is in for general information about its management. Dashes in the range site column mean that the particular mapping unit is not used for range because of lack of sufficient forage. Other information is given in tables or text as follows:

Acreage and extent, table 1, p. 14.
Storie index and natural land types, p. 171
Estimated yields and optimum management practices, tables 2 through 15, pp. 174 through 190.

Engineering uses of the soils, tables 16 through 18, pp. [illegible] through [illegible]
Nonfarm uses of the soils, table 19, p. 238.

Map symbol	Mapping unit	Described on page	Capability unit		Range site		Natural land type	Storie index rating
			Symbol	Page	Number	Page		
AaA	Academy loam, 0 to 3 percent slopes	19	IIIs-8 (17)	167	8	195	E1	42
AaB	Academy loam, 3 to 9 percent slopes	19	IIIe-8 (17)	165	8	195	E1	39
AcB	Ahwahnee coarse sandy loam, 3 to 9 percent slopes	21	IIIe-8 (18)	165	2	193	E3	48
AcC	Ahwahnee coarse sandy loam, 9 to 15 percent slopes	21	IIIe-8 (18)	165	2	193	E3	[illegible]
AcD	Ahwahnee coarse sandy loam, 15 to 30 percent slopes	21	VIe-1 (17, 18)	168	2	193	E3	39
AcE	Ahwahnee coarse sandy loam, 30 to 45 percent slopes	22	VIIe-1 (18)	170	2	193	E11	19
AdD	Ahwahnee very rocky coarse sandy loam, 3 to 30 percent slopes	22	VIs-1 (18)	169	2	193	E4	27
AdE	Ahwahnee very rocky coarse sandy loam, 30 to 45 percent slopes	22	VIIs-8 (18)	171	2	193	E12	12
AdF	Ahwahnee very rocky coarse sandy loam, 45 to 70 percent slopes	22	VIIs-8 (18)	171	2	193	E12	6
AeD	Ahwahnee very rocky coarse sandy loam, shallow, 3 to 30 percent slopes	23	VIs-1 (18)	169	2	193	F8	15
AeF	Ahwahnee very rocky coarse sandy loam, shallow, 30 to 70 percent slopes	23	VIIs-8 (18)	171	2	193	E16	4
AhD	Ahwahnee-Sierra coarse sandy loams, 15 to 30 percent slopes	23	VIe-1 (17, 18)	168	2	193	E3	38
AhE	Ahwahnee-Sierra coarse sandy loams, 30 to 45 percent slopes	23	VIIe-1 (18)	170	2	193	E11	20
AkF	Ahwahnee-Tollhouse-Rock land complex, 45 to 70 percent slopes	23	VIIs-8 (18)	171	10	196	E12	6
AlB	Aiken loam, 3 to 9 percent slopes	25	IIe-1 (22)	163	1	193	E1	68
AmF	Aiken very rocky loam, 45 to 70 percent slopes	25	VIIs-1 (22)	170	1	193	E12	9
An	Alamo clay	26	IIIw-5 (17, 18)	166	8	195	C14-lo	12
AoA	Atwater loamy sand, 0 to 3 percent slopes	27	IIIs-1 (17)	166	---	---	A5	70
AoB	Atwater loamy sand, 3 to 9 percent slopes	27	IIIs-4 (17)	166	---	---	A5	65
ApA	Atwater loamy sand, moderately deep, 0 to 3 percent slopes	28	IIIs-3 (17)	166	---	---	A11	52
ArA	Atwater sandy loam, 0 to 3 percent slopes	28	IIs-4 (17)	164			A1	88
ArB	Atwater sandy loam, 3 to 9 percent slopes	28	IIe-1 (17)	163	---	---	A1	81
AsA	Atwater sandy loam, clay substratum, 0 to 3 percent slopes	28	IIIs-3 (17)	166	---	---	A9	53
AtA	Atwater sandy loam, moderately deep, 0 to 3 percent slopes	29	IIIs-3 (17)	166			A9	65
AuB	Auberry coarse sandy loam, 3 to 9 percent slopes	30	IIIe-8 (18)	165	2	193	E3	44
AuB2	Auberry coarse sandy loam, 3 to 9 percent slopes, eroded	31	IIIe-8 (18)	165	2	193	E3-3m	36
AuC	Auberry coarse sandy loam, 9 to 15 percent slopes	31	IVe-8 (18)	168	2	193	E3	42
AuC2	Auberry coarse sandy loam, 9 to 15 percent slopes, eroded	31	IVe-8 (18)	168	2	193	E3-3m	34

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Map symbol	Mapping unit	Described on page	Capability unit Symbol	Capability unit Page	Range site Number	Range site Page	Natural land type	Storie index rating
AuD	Auberry coarse sandy loam, 15 to 30 percent slopes	31	VIe-1 (17, 18)	168	2	193	[illegible]	37
AuD2	Auberry coarse sandy loam, 15 to 30 percent slopes, eroded	37	VIe-1 (17, 18)	168	2	193	E3-3m	26
AuE	Auberry coarse sandy loam, 30 to 45 percent slopes	32	VIIe-1 (18)	170	2	193	E11	19
AuF	Auberry coarse sandy loam, 45 to 70 percent slopes	32	VIIe-1 (18)	170	2	193	E11	10
AvD	Auberry very rocky coarse sandy loam, 3 to 30 percent slopes	30	VIs-1 (18)	169	2	193	E4	25
AvE	Auberry very rocky coarse sandy loam, 30 to 45 percent slopes	32	VIIs-8 (18)	171	2	193	E12	12
AvF	Auberry very rocky coarse sandy loam, 45 to 70 percent slopes	32	VIIs-8 (18)	171	2	193	F12	6
AwF	Auberry very rocky coarse sandy loam, shallow, 30 to 70 percent slopes	33	VIIs-8 (18)	171	2	193	E16	6
AxD	Auberry-Sierra coarse sandy loams, 15 to 30 percent slopes	33	VIe-1 (17, 18)	168	2	193	E3	48
AxE	Auberry-Sierra coarse sandy loams, 30 to 45 percent slopes	33	VIIe-1 (18)	170	2	193	E11	26
AxF	Auberry-Sierra coarse sandy loams, 45 to 70 percent slopes	33	VIIe-1 (18)	170	2	193	E11	13
AyF	Auberry-Sierra very rocky coarse sandy loams, 45 to 70 percent slopes	33	VIIs-8 (18)	171	2	193	F12	6
AzF	Auberry-Tollhouse Rock land complex, 30 to 70 percent slopes	34	VIIs-8 (18)	171	10	196	E12	6
BaF	Basic igneous rock land	34	VIIIs-8 (18)	171	---	---	F17	5
BcC	Blasingame loam, 3 to 15 percent slopes	36	IIIe-8 (18)	165	4	194	E1	51
BcD	Blasingame loam, 15 to 30 percent slopes	36	IVe-8 (18)	168	4	194	E2	45
BcE	Blasingame loam, 30 to 45 percent slopes	37	VIe-8 (18)	169	4	194	E9	[illegible]
BcF	Blasingame loam, 45 to 70 percent slopes	36	VIIe-1 (18)	170	4	194	E9	13
BeF	Blasingame loam, shallow, 45 to 70 percent slopes	36	VIIe-1 (18)	170	5	194	E15	8
BgD	Blasingame very rocky loam, 3 to 30 percent slopes	37	VIs-8 (18)	170	4	194	E4	34
BgF	Blasingame very rocky loam, 45 to 70 percent slopes	37	VIIs-8 (18)	171	4	194	F12	8
BkF	Blasingame extremely rocky loam, shallow, 30 to 70 percent slopes	37	VIIs-8 (18)	171	10	196	E16	8
BlD	Blasingame clay loam, shallow, 9 to 30 percent slopes	35	IVe-4 (18)	167	5	194		17
BlE	Blasingame clay loam, shallow, 30 to 45 percent slopes	36	VIIe-4 (18)	170	5	194	E15	13
BmE	Blasingame very rocky clay loam, 30 to 45 percent slopes	36	VIs-81 (18)	170	4	194	E12	14
Br	Borden loam	38	I-1 (17, 18)	163	---	---	A2	81
Bs	Borden loam, saline-alkali	38	IIs-6 (17)	164	---	---	A2-2s	39
Bt	Borden loam, moderately deep	39	IIs-3 (17)	164	---	---	A2	73
Bu	Borden loam, moderately deep, saline-alkali	39	IIIs-6 (17)	166	---	---	A2-2s	42
Ca	Cajon loamy coarse sand	41	IIIs-4 (17)	166	---	---	A5	63
Cb	Cajon loamy coarse sand, saline-alkali	40	IIIs-4 (17)	166	---	---	A5-2s	50
Cc	Cajon coarse sandy loam	40	IIIs-4 (17)	166	---	---	A5	72
Cd	Cajon coarse sandy loam, saline-alkali	40	IIIs-4 (17)	166	---	---	A5-2s	58
Ce	Cajon coarse sandy loam, moderately deep, saline-alkali	41	IIIs-4 (17)	166	---	---	A6-2s	41
CfA	Calhi loamy sand, 0 to 3 percent slopes	42	IIIs-4 (17)	166	---	---	A5	72
CfB	Calhi loamy sand, 3 to 9 percent slopes	42	IIIs-4 (17)	166	---	---	A5	68
CgA	Calhi loamy sand, moderately deep, 0 to 3 percent slopes	42	IIIs-4 (17)	166			A6	77
CmA	Centerville clay, 0 to 3 percent slopes	43	IIs-5 (17)	164	3	194	E2	55

Map symbol	Mapping unit	Described on page	Capability unit		Range site		Natural land type	Storie index rating
			Symbol	Page	Number	Page		
CbC	Centerville clay, 3 to 15 percent slopes	43	IIIe-5 (17)	165	5	194	--	[illegible]
CkB	Centerville cobbly clay, 3 to 9 percent slopes	44	IIIe-5 (17)	165	5	194	E2	25
CkD	Centerville cobbly clay, 9 to 30 percent slopes	[illegible]	IIIe-5 (17)	165	5	194	E2	22
Cl	Chino sandy loam	46	I-1 (17, 18)	163		---	A1-1f	90
Cm	Chino sandy loam, saline-alkali	46	IIs-6 (17)	164	---		A1-1f-2s	54
Cn	Chino fine sandy loam	45	I-1 (17, 18)	163	---	---	A1-1f	95
Co	Chino fine sandy loam, saline-alkali	45	IIs-6 (17)	164	---	---	A1-1f-2s	57
Cp	Chino fine sandy loam, moderately deep, saline-alkali	45	IIIs-6 (17)	166	---	---	A2-1f-2s	58
Cr	Chino loam	45	I-1 (17, 18)	163	---	-	A1-1f	95
Cs	Chino loam, saline-alkali	46	IIs-6 (17)	164		---	A1-1f-2s	57
CtA	Chualar sandy loam, 0 to 3 percent slopes	47	I-1 (17, 18)	163	4	194	--	81
CtB	Chualar sandy loam, 3 to 9 percent slopes	47	I-1 (17, 18)	163	4	194	[illegible]	74
CuC	Cibo clay, 3 to 15 percent slopes	48	IIIe-5 (18)	165	3	194	E2	[illegible]
CuD	Cibo clay, 15 to 30 percent slopes	49	IVe-5 (18)	168	3	194	E2	[illegible]
CuE	Cibo clay, 30 to 45 percent slopes	49	VIe-8 (18)	169	3	194	E10	[illegible]
CvD	Cibo very rocky clay, 3 to 30 percent slopes	49	VIe-8 (18)	[illegible]	3	194	E4	18
CvE	Cibo very rocky clay, 30 to 45 percent slopes	49	[illegible] (18)	170	3	194	E12	[illegible]
CvF	Cibo very rocky clay, 45 to 70 percent slopes	48	[illegible]-8 (18)	171	3	194	[illegible]	[illegible]
CwD	Cibo extremely rocky clay, 3 to 30 percent slopes	49	VIIe-7 (17, 18)	[illegible]	3	194	E4	19
CwE	Cibo extremely rocky clay, 30 to 45 percent slopes	50	VIIe-7 (17, 18)	170	3	194	E12	10
CxC	Coarsegold fine sandy loam, 9 to 15 percent slopes	51	IIIe-8 (18)	165	[illegible]	[illegible]	E1	59
CxD	Coarsegold fine sandy loam, 15 to 30 percent slopes	51	IVe-8 (18)	168	1	193	E1	55
CxE	Coarsegold fine sandy loam, 30 to 45 percent slopes	51	VIe-8 (18)	169	1	193	E9	19
CxF	Coarsegold fine sandy loam, 45 to 70 percent slopes	51	VIIe-1 (18)	170	1	193	E9	13
CyF	Coarsegold rocky fine sandy loam, 45 to 70 percent slopes	51	VIIe-1 (18)	170	1	193	E12	8
[illegible]	Colluvial land	52	VIIs-8 (18)	171	4	194	E12	15
CmB	Cometa sandy loam, 3 to 9 percent slopes	53	IVe-3	[illegible]	8	195	F5	32
CmC	Cometa sandy loam, 9 to 15 percent slopes	53	IVe-3 (17)	[illegible]	8	195	F5	[illegible]
CmD	Cometa sandy loam, 15 to 30 percent slopes	53	VIe-3 (17)	[illegible]	8	195	F5	[illegible]
CnB	Cometa loam, 3 to 9 percent slopes	53	IVe-3 (17)	167	8	195	F5	34
CoB	Cometa-San Joaquin sandy loams, 3 to 9 percent slopes	54	IVe-3 (17)	167	8	195	F5	30
DeA	Delhi sand, 0 to 3 percent slopes	55	IVs-4 (17)	168			A5	[illegible]
DeB	Delhi sand, 3 to 9 percent slopes	55	IVs-4 (17)	168		---	A5	40
DhA	Delhi loamy sand, 0 to 3 percent slopes	55	IIIs-4 (17)	166			A5	72
DhB	Delhi loamy sand, 3 to 9 percent slopes	55	IIIs-4 (17)	166			A5	68
DlA	Delhi loamy sand, moderately deep, 0 to 3 percent slopes	55	IIIs-4 (17)	166	---	---	A6	77
Dm	Dello loamy sand	57	IIIw-4 (17)	166		-	A3-1p	58
Dn	Dello sandy loam	57	IIIw-4 (17)	166	---		A1-1p	65
DpE	Delpiedra extremely stony loam, 30 to 45 percent slopes	58	VIs-9 (18)	170	9	196	E16-4p	11
DpF	Delpiedra extremely stony loam, 45 to 70 percent slopes	58	VIIs-8 (18)	171	9	196	E16-4p	5
DsF	Delpiedra-Rancher extremely stony loams, 45 to 70 percent slopes	58	VIIs-8 (18)	171	9	196	E16-4p; E12-1p	5
Ec	El Peco sandy loam	60	IIIs-6 (17)	166	---	--	B13-2s	22
Ed	El Peco fine sandy loam	60	IIIs-6 (17)	166		---	B13-2s	[illegible]
Ep	El Peco loam	60	IIIs-6 (17)	166	---	--	B13-2s	[illegible]

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit: Symbol	Capability unit: Page	Range site: Number	Range site: Page	Natural land type	Storie index rating
Es	Exeter sandy loam	61	IIIs-8 (17)	167		---	C13	4
Et	Exeter sandy loam, shallow	61	IIIs-8 (17)	167	---	---	C13	29
Ex	Exeter loam	62	IIIs-8 (17)	167			C13	45
FaB	Fallbrook sandy loam, 3 to 9 percent slopes	64	IIIe-8 (18)	165	6	195	E1	54
FaC	Fallbrook sandy loam, 9 to 15 percent slopes	64	IVe-8 (18)	168	6	195	E1	[illegible]
FaD	Fallbrook sandy loam, 15 to 30 percent slopes	64	[illegible] (17, 18)	165	6	195	E1	45
FaF	Fallbrook sandy loam, 30 to 45 percent slopes	64	VIIe-1 (18)	170	6	195	E9	23
FbB	Fallbrook sandy loam, shallow, 3 to 9 percent slopes	64	IVe-4 (18)	167	7	195	E5	31
FbD	Fallbrook sandy loam, shallow, 9 to 30 percent slopes	65	VIe-41 (18)	169	7	195	E5	27
FcD	Fallbrook very rocky sandy loam, 3 to 30 percent slopes	63	VIs-1 (18)	169	6	195	F4	37
FcF	Fallbrook very rocky sandy loam, 30 to 70 percent slopes	63	VIIs-8 (18)	171	6	195	B12	9
FdD	Fallbrook very rocky sandy loam, shallow, 3 to 30 percent slopes	63	VIs-41 (18)	169	7	195	E8	21
FdF	Fallbrook very rocky sandy loam, shallow, 30 to 70 percent slopes	63	VIIs-8 (18)	171	7	195	E16	8
FeE	Fallbrook extremely rocky sandy loam, 30 to 45 percent slopes	64	VIIs-7 (17, 18)	170	10	196	E12	9
FhE	Fancher extremely stony loam, 30 to 45 percent slopes	66	VIs-9 (18)	170	9	196	F12-4p	12
FhF	Fancher extremely stony loam, 45 to 70 percent slopes	66	VIIs-8 (18)	171	9	196	E12-4p	6
FlE	Fancher-Blasingame complex, 30 to 45 percent slopes	66	[illegible] (18)	[illegible]	9	196	E12-4p, E9	18
FlF	Fancher-Blasingame complex, 45 to 70 percent slopes	66	VIIs-8 (18)	171	9	196	E12-4p, E9	8
Fm	Foster sandy loam	67	IIs-4 (17)	164			A1-1f	86
Fn	Foster loam	68	I-1 (17, 18)	163		---	A1-1f	90
Fo	Foster loam, saline-alkali	68	IIs-6 (17)	164	--		A1-1f-2a	43
Fp	Foster loam, moderately deep	68	IIs-3 (17)	164		---	A9-1f	47
Fq	Foster loam, moderately deep, saline-alkali	68	IIIs-6 (17)	166		---	A9-1f-2a	38
Fr	Fresno sandy loam	71	IIIs-6 (17)	166	--		B13-2m	15
Ft	Fresno sandy loam, shallow	71	IIIs-6 (17)	166	--	---	B13-2m	4
Fu	Fresno fine sandy loam	70	IIIs-6 (17)	166	---	---	B13-2m	16
Fv	Fresno fine sandy loam, shallow	71	IIIs-6 (17)	166			B13-2m	4
Fw	Fresno clay loam	[illegible]	IIIs-6 (17)	166	---	--	B13-2m	3
Fx	Fresno-Traver complex	71	IIIs-6 (17)	166	---	--	B13-2m, B1-2m	10
Fy	Friant fine sandy loam, 9 to 30 percent slopes	[illegible]	[illegible] (18)	[illegible]	7	195	F5	24
FzE	Friant fine sandy loam, 30 to [illegible] percent slopes	[illegible]	VIIe-1 (18)	170	[illegible]	19[illegible]	E13	12
Gc	Grangeville sandy loam	75	IIs-3 (17)	164	---		A1-1f	86
Gd	Grangeville sandy loam, saline alkali	76	IIs-6 (17)	164		---	A1-1f-2a	51
Ge	Grangeville sandy loam, sandy substratum	76	IIIs-4 (17)	166	-		A1-1f	68
Gf	Grangeville fine sandy loam	73	I-1 (17, 18)	163	--		A1-1f	90
Gg	Grangeville fine sandy loam, saline alkali	74	IIs-6 (17)	164	-		A1-1f-2a	77
Gh	Grangeville fine sandy loam, water table	74	IIw-2 (17)	163			A1-1p	66
Gk	Grangeville fine sandy loam, water table, saline-alkali	74	IIw-2 (17)	163	-		A1-1p-2a	48
Gl	Grangeville fine sandy loam, gravelly substratum	[illegible]	IIs-[illegible] (17)	164		---	A1-1f	77
Gm	Grangeville fine sandy loam, sandy substratum	75	IIs-0 (17)	164			A1-1f	77

Map symbol	Mapping unit	Described on page	Capability unit: Symbol	Capability unit: Page	Range site: Number	Range site: Page	Natural land type	Storie index rating
Gn	Grangeville fine sandy loam, hard substratum	75	IIs-3 (17)	164	---	---	A9-1f	63
Go	Grangeville fine sandy loam, hard substratum, saline-alkali	75	IIIs-6 (17)	166	---	---	A9-1f-2a	38
Gp	Grangeville soils, channeled	76	IIw-2 (17)	163	11	196	A1-1p-5ch	36
GrF	Granitic rock land	76	VIIIs-8 (18)	171	---	---	E17	5
GsA	[illegible]	78	[illegible]	[illegible]	---	---	A5	81
GtA	Greenfield sandy loam, 0 to 3 percent slopes	77	I-1 (17, 18)	163	---	---	A1	90
GtB	Greenfield sandy loam, 3 to 9 percent slopes	78	IIe-1 (17)	163	---	---	A1	81
GuA	Greenfield sandy loam, moderately deep, 0 to 3 percent slopes	78	[illegible]	[illegible]	---	---	A9	[illegible]
[illegible]	[illegible] coarse sandy loam	[illegible]	[illegible]	[illegible]			A5	[illegible]
[illegible]	[illegible] coarse sandy loam, hard substratum	80	IIIs-3 (17)	[illegible]	---	---	A11	48
[illegible]	[illegible] sandy loam	81	[illegible]	[illegible]	---	---	A1	[illegible]
Hd	Hanford sandy loam, benches	81	IIe-1 (17)	163	---	---	A1	86
[illegible]	[illegible] sandy loam, gravelly substratum	82	[illegible]	[illegible]	---	---	A1-1f	[illegible]
[illegible]	[illegible] sandy loam, hard substratum	[illegible]	IIIs-4 (17)	166			A1-1f	[illegible]
[illegible]	[illegible] sandy loam, silty substratum	82	IIs-3 (17)	164	---	---	A2	[illegible]
Hh	Hanford sandy loam, clay loam substratum	82	IIs-4 (17)	164	---	---	A2	86
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			A9	[illegible]
[illegible]	Hanford gravelly sandy loam	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]
Hm	Hanford fine sandy loam	79	I-1 (17, 18)	163	---	---	A1	100
[illegible]	[illegible] fine sandy loam, gravelly substratum	80	[illegible]	[illegible]			A1-1f	[illegible]
Ho	Hanford fine sandy loam, silty substratum	81	IIs-3 (17)	164	---	---	A2	95
Hp	Hanford fine sandy loam, clay loam substratum	80	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible] fine sandy loam, hard substratum	80	[illegible]	166			[illegible]	[illegible]
[illegible]	Hesperia coarse sandy loam	84	[illegible]	[illegible]			[illegible]	[illegible]
Hsc	Hesperia coarse sandy loam, saline-alkali	84	[illegible]	[illegible]	[illegible]		A5-2s	64
Hsd	Hesperia sandy loam	85	IIs-4 (17)	164	---	---	A1	95
[illegible]	Hesperia sandy loam, saline-alkali	85	[illegible]	[illegible]			[illegible]	[illegible]
Hsm	Hesperia sandy loam, moderately deep	85	[illegible]	164	[illegible]	[illegible]	[illegible]	90
Hsn	Hesperia sandy loam, moderately deep, saline-alkali	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]
Hso	Hesperia sandy loam, shallow	[illegible]	[illegible]	[illegible]	[illegible]	---	[illegible]	[illegible]
Hsp	Hesperia sandy loam, shallow, saline-alkali	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
Hsr	Hesperia fine sandy loam	84	I-1 (17, 18)	163	---	---	A1	100
[illegible]	Hesperia fine sandy loam, saline-alkali	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]
Hst	Hesperia fine sandy loam, moderately deep	[illegible]	IIs-3 (17)	[illegible]	---	---	[illegible]	[illegible]
[illegible]	Hesperia fine sandy loam, moderately deep, saline-alkali	85	[illegible]	166			[illegible]	5
HtC	Hideaway extremely stony loam, 3 to 15 percent slopes	87	VIIs-7 (17, 18)	170	10	196	E8	5
Hu	Hildreth clay	88	IIIw-5 (17, 18)	166	---	---	A4-1f	36
HvE	Holland coarse sandy loam, 15 to 45 percent slopes	89	VIe-1 (22)	169	2	193	B11	26
HwA	Honcut fine sandy loam, 0 to 3 percent slopes	90	[illegible]	[illegible]			A1	[illegible]
HwB	Honcut fine sandy loam, 3 to 9 percent slopes	90	IIe-1 (17, 18)	163	---	---	A1	90
HyA	Honcut fine sandy loam, gravelly substratum, 0 to 3 percent slopes	90	IIIs-4 (17)	166	---	---	A1-1f	77
HzA	Honcut fine sandy loam, hard substratum, 0 to 3 percent slopes	[illegible]	IIIs-3 (17)	[illegible]			A9	65
KeC	Keefers loam, 3 to 15 percent slopes	[illegible]	IIIe-8 (18)	[illegible]	8	195	[illegible]	32
KfD	Keefers cobbly loam, 3 to 30 percent slopes	91	VIe-8 (18)	169	8	195	[illegible]	18
KmC	Keyes cobbly clay loam, 3 to 15 percent slopes	[illegible]	[illegible]	[illegible]	8	[illegible]	[illegible]	[illegible]
LbB	Los Robles sandy loam, 2 to 9 percent slopes	94	IIe-1 (17, 18)	163	---	---	A1	81

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit: Symbol	Capability unit: Page	Range site: Number	Range site: Page	Natural land type	Storie index rating
LgB	Los Robles sandy loam, gravelly substratum, 2 to 9 percent slopes	91	IIIs-4 [illegible]	166	[illegible]		A1-[illegible]	[illegible]
[illegible]	Los Robles loam, [illegible] to 3 percent slopes	3	[illegible]	[illegible]			A1	95
[illegible]	Los Robles loam, [illegible] percent slopes	[illegible]	[illegible]	163			A1	[illegible]
LnB	Los Robles loam, hard substratum, 2 to 9 percent slopes	[illegible]	[illegible]	[illegible]		---	A[illegible]	86
[illegible]	Los Robles [illegible] loam, [illegible] to 3 percent slopes	[illegible]	IIe [illegible]	163		---	A9	63
Mn	Madera sandy loam	[illegible]	[illegible]	[illegible]		---	[illegible]	31
Mo	Madera loam	96	[illegible]	[illegible]	8	195	[illegible]3	36
[illegible]	Madera loam, [illegible]-alkali	[illegible]	[illegible]	166	8	[illegible]	[illegible]3	38
Mc	Madera [illegible] loam	[illegible]	IIIs-[illegible]	[illegible]	---		[illegible]13 2m	20
Mf	Merced [illegible] loam	[illegible]	[illegible]	[illegible]	8	195	[illegible]	[illegible]
Mg	Merced [illegible] loam, slightly [illegible]	96	[illegible]	163	[illegible]	---	89	[illegible]
Mh	Merced [illegible]	[illegible]	[illegible]	163			B[illegible] 2s	63
[illegible]	Merced [illegible], slightly saline	[illegible]	[illegible]	164	---	---	B1	[illegible]
[illegible]	Merced [illegible], moderately [illegible]	[illegible]	[illegible]	164	---		B[illegible] 2s	[illegible]
Mm	Merced [illegible], saline alkali	[illegible]	[illegible]	[illegible]		---	[illegible] 2s	15
MnD	Millerton fine sandy loam, 9 to 30 percent slopes	[illegible]	[illegible]	168	[illegible]		B1[illegible]	[illegible]
MnE	Millerton fine sandy loam, 30 to 45 percent slopes	[illegible]	[illegible]	[illegible]	5	194	E5	[illegible]
MnF	Millerton fine sandy loam, 45 to 70 percent slopes	[illegible]	[illegible]	[illegible]	5	194	[illegible]	13
MnF2	Millerton fine sandy loam, 45 to 70 percent slopes, eroded	[illegible]	[illegible]	[illegible]	[illegible]	194	F1	[illegible]
MoD	Millerton rocky fine sandy loam, [illegible] percent slopes	100	VIIe-4 (18)	170	5	194	E15-3m	3
MoE	Millerton very rocky fine sandy loam, 30 to [illegible] percent slopes	100	VIs 41 (18)	169	5	194	E8	16
MoF	Millerton very rocky fine sandy loam, 45 to 70 percent slopes	[illegible]	[illegible]	[illegible]	5	194	[illegible]	8
MpC	Montpellier coarse sandy loam, 9 to 15 percent slopes	[illegible]	IIIs-8 [illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]
MpD	Montpellier coarse sandy loam, 15 to 30 percent slopes	[illegible]	[illegible]	167	[illegible]	[illegible]	[illegible]3	52
[illegible]	Montpellier [illegible], 3 to 9 percent slopes	[illegible]	[illegible]	169	[illegible]	[illegible]	[illegible]3	40
Mt	Montpellier [illegible], 9 to 15 percent slopes	[illegible]	IIe-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
No	[illegible] loam	[illegible]	[illegible]	[illegible]	5	19[illegible]	F2	[illegible]
Ns	[illegible] loam, saline-alkali	[illegible]	[illegible]	163		[illegible]	A1	[illegible]
Pa	Pachappa loam	[illegible]	[illegible]	164	[illegible]		A1-2s	60
Pc	Pachappa loam, saline-alkali	[illegible]	[illegible]	163	---	---	A1	[illegible]
Pd	Pachappa loam, moderately deep	[illegible]	[illegible]	164	---	[illegible]	[illegible]	[illegible]
Pe	Pachappa loam, moderately deep, saline-alkali	[illegible]	[illegible]	[illegible]		[illegible]	A2	[illegible]
PfB	Piper sandy loam, [illegible] percent slopes	[illegible]	IIs-6 [illegible]	[illegible]	[illegible]		A2 2s	56
PgB	Piper fine sandy loam, [illegible] percent slopes	[illegible]	[illegible]	[illegible]		---	B[illegible]	51
PhB	Piper-Rossi complex, 0 to 9 percent slopes	[illegible]	[illegible]	[illegible]	---		B1 2s	23
			[illegible]	[illegible]	---		B1-[illegible], [illegible]	30
Pk	Pits							
[illegible]	[illegible]	[illegible]	IIIw-1 [illegible]	[illegible]	[illegible]		A14	5
PmB	Pollasky sandy loam, 3 to 9 percent slopes	[illegible]	[illegible]	[illegible]			B[illegible]	5
PmC	Pollasky sandy loam, 9 to 15 percent slopes	[illegible]	[illegible]	[illegible]	6	[illegible]	E1	[illegible]
PmD	Pollasky sandy loam, 15 to 30 percent slopes	[illegible]	[illegible]	[illegible]	6	[illegible]	F1	53
PnB	Pollasky fine sandy loam, 3 to 9 percent slopes	[illegible]	[illegible] 13	168	6	195	[illegible]	38
PnC	Pollasky fine sandy loam, 9 to 15 percent slopes	109	IIIe-8 (17)	165	6	195	E1	63
PoC	Pollasky-Montpellier complex, 3 to [illegible] percent slopes	109	[illegible]	[illegible]	[illegible]	[illegible]	F1	[illegible]
		110	IVe-3 (17)	167	6	195	E1; E3	52

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PoE	Pollasky-Montpellier complex, 15 to 30 percent slopes	110	VIe-3 (17)	169	6	195	E1; E5	47
Pp[illegible]	Pollasky Rocklin sandy loams, 3 to 15 percent slopes	110	IVe-3 (17)	167	6	195	E1; E5	40
Pr	Pond sandy loam	113	IIs-6 (17)	164	---	---	B2-2a	35
P[illegible]	Pond sandy loam, moderately deep	[illegible]	IIIs-[illegible]	[illegible]	---	---	B2-2a	[illegible]
[illegible]t	Pond fine sandy loam	112	IIs-6 (17)	164	---	---	B2-2a	16
Pu	Pond fine sandy loam, moderately deep	112	II[illegible] (17)	[illegible]			[illegible]	[illegible]
P[illegible]	Pond loam	11[illegible]	[illegible]	[illegible]	---	---	B2-2a	[illegible]
P[illegible]	Pond loam, moderately deep	113	IIIs-6 (17)	166	---	---	B2-2a	11
PxA	Porterville clay, 0 to 3 percent slopes	114	IIs-5 (17)	164	3	194	L4	54
[illegible]	Porterville clay, 3 to 15 percent slopes	114	IIIe-5 (17)	165	3	194	C4	49
[illegible]	Porterville cobbly clay, 3 to 15 percent slopes	[illegible]14	IIIe-5 (17)	[illegible]	3	194	[illegible]	3
[illegible]	Porterville very cobbly clay, 0 to 30 percent slopes	[illegible]	[illegible] (17, 18)	[illegible]	3	19[illegible]	[illegible]	15
P[illegible]B	Positas gravelly loam, 3 to 9 percent slopes	[illegible]	[illegible]	[illegible]	5	195	E4	28
P[illegible]D	Positas gravelly loam, 9 to 30 percent slopes	1[illegible]6	[illegible] (17)	169	8	195	E4	21
PaE	Positas gravelly loam, 30 to 45 percent slopes	116	VIe-3 (17)	169	8	195	E12	11
Ra	Ramona sandy loam	[illegible]	[illegible]	[illegible]	[illegible]		C2	[illegible]
Rb	Ramona sandy loam, hard substratum	1[illegible]8	IIe-3 (17)	164			C13	[illegible]
Rc	Ramona loam	117	I-1 (17, 18)	163	---	---	C2	85
R[illegible]	Ramona loam, gravelly substratum	11[illegible]	[illegible]	[illegible]	---	---	C[illegible]	[illegible]
Ro	Ramona loam, hard substratum	118	IIe-3 (17)	164	---	---	C13	65
RfC	Redding gravelly loam, 3 to 15 percent slopes	[illegible]19	[illegible]	[illegible]	8	[illegible]	[illegible]28-4p	19
RgB	Redding gravelly loam, shallow, [illegible] to 9 percent slopes	119	VIe-3 (17)	169	8	195	D28-4p	14
Rh	Riverwash	119	VIIIw-4 (17)	171	11	196	A14	5
RkB	Rocklin sandy loam, 3 to 9 percent slopes	120	IIIe-6 (17)	[illegible]	8	[illegible]	E1	28
RlD	Rocklin sandy loam, pumiceous variant, 3 to 30 percent slopes	121	IVe-3 (17)	167	8	195	E5	17
Ro	Rossi fine sandy loam	122	IVs-6 (17)	168	---	---	B2-2a	32
Rs	Rossi clay loam	123	IVs-6 (17)	168	---	---	B2-2a	27
Sa	Sandy alluvial land	123	IIw-2 (17)	163	---	---	A2-1o	19
Sb	Sandy alluvial land, leveled	123	IIs-4 (17)	164	---	---	B1	76
ScA	San Joaquin sandy loam, 0 to 3 percent slopes	125	IIIs-8 (17)	167	8	195	C13	31
SdA	San Joaquin sandy loam, shallow, 0 to 3 percent slopes	125	IIIs-8 (17)	167	8	195	C13	23
SdB	San Joaquin sandy loam, shallow, 3 to 9 percent slopes	125	IVe-3 (17)	167	8	195	C13	20
SeA	San Joaquin loam, 0 to 3 percent slopes	12[illegible]	IIIs-8 (17)	167	8	195	C13	33
SfA	San Joaquin loam, gravelly substratum, 0 to 3 percent slopes	125	IIIs-8 (17)	167	[illegible]	--	C13	33
SgA	San Joaquin loam, shallow, 0 to 3 percent slopes	125	IIIs-8 (17)	167	8	195	C13	24
SgB	San Joaquin loam, shallow, 3 to 9 percent slopes	126	IVe-3 (17)	16[illegible]	8	195	C13	21
ShB	San Joaquin-Alamo complex, 3 to 9 percent slopes	126	IVe-3 (17)	167	---	---	C13; C14-1o	25
SkB	Sesame sandy loam, 3 to 9 percent slopes	[illegible]	IIIe-8 (18)	165	6	195	E1	41
SkC	Sesame sandy loam, 9 to 15 percent slopes	[illegible]	IVe-8 (18)	168	6	195	E1	36
SkE	Sesame sandy loam, 15 to 30 percent slopes	128	VIe-1 (17, 18)	168	6	195	E1	3[illegible]
SlB	Sesame loam, 3 to 9 percent slopes	12[illegible]	IIIe-8 (18)	165	6	195	E1	43
SlC	Sesame loam, 9 to 15 percent slopes	[illegible]	IVe-8 (18)	168	6	195	E1	36

Map symbol	Mapping unit	Described on page	Capability unit		Range site		Natural land type	Storie index rating
			Symbol	Page	Number	Page		
SmF	Shaver coarse sandy loam, 15 to 45 percent slopes	[illegible]	VIe-1 (22)	169	2	193	E11	[illegible]
SnC	Sierra sandy loam, 9 to 15 percent slopes	130	IVe-8 (18)	168	2	193	E1	58
SnD	Sierra sandy loam, 15 to 30 percent slopes	130	[illegible] 18	168	2	193	[illegible]	[illegible]
[illegible]	Sierra sandy loam, 30 to 45 percent slopes	131	VIe-1 (18)	[illegible]		[illegible]	9	30
SnF	Sierra sandy loam, 45 to 70 percent slopes	131	VIIe-1 (18)	[illegible]	[illegible]	193	[illegible]	14
SoD	Sierra very rocky sandy loam, 3 to 30 percent slopes	130	VIs-1 (18)	169	2	193	E4	36
SoE	Sierra very rocky sandy loam, 30 to 45 percent slopes	130	VIIs-8 (18)	171	2	193	E12	16
SoF	Sierra very rocky sandy loam, 45 to 70 percent slopes	130	VIIs-8 (18)	171	2	193	E12	8
StF	Sierra-Tollhouse Rock land complex, 45 to 70 percent slopes	131	VIIs-8 (18)	171	10	196	E9; E16;	11
Sw	Swamp	131	Vw-2 (17)	168	11	196	B17	5
Te	Temple loam	133	I-1 (17, 18)	163	---	---	B1	95
Tb	Temple loam, saline	133	IIs-6 (17)	164			B1-2s	67
Tc	Temple loam, saline-alkali	133	IIs-6 (17)	164	---	---	B1-2s	57
Td	Temple clay loam	132	I-1 (17, 18)	163	---	---	B1	81
Te	Temple clay loam, saline	133	IIs-6 (17)	164			B1-2s	65
Tf	Temple clay loam, saline-alkali	133	IIs-6 (17)	164			B1-2s	61
Tg	Temple clay [illegible]	133	IIs-5 (17)	164			B3	57
[illegible]	[illegible] escarpments	134	VIIIe-1 (17, 18)	[illegible]			C17	10
TkB	[illegible] loam, 3 to [illegible] percent slopes	135	IIIe-8 (18)	165	5	194	E5	41
TkD	[illegible] loam, 15 to 30 percent slopes	135	IVe-8 (18)	168	5	194	E5	36
[illegible]	[illegible] loam, 30 to 45 percent slopes	135	VIe-1 (18)	169	5	194	E13	18
Tk[illegible]	[illegible] loam, 45 to 70 percent slopes	135	VIIe-4 (18)	170	5	194	E13	8
[illegible]	[illegible] very rocky loam, 3 to 30 percent slopes	135	VIs-8 (18)	[illegible]	5	194	E8	6
TlF	[illegible] very rocky loam, 30 to 70 percent slopes	136	VIIs-8 (18)	171	10	196	E16	8
TmF	Tollhouse extremely rocky coarse sandy loam, 30 to 70 percent slopes	137	VIIIs-8 (18)	171	---	---	E16	3
TnF	Toomes extremely cobbly loam, 30 to 70 percent slopes	138	VIIs-7 (17, 18)	170	10	196	E16	4
ToC	Trabuco loam, 9 to 15 percent slopes	139	IIIe-8 (18)	165	1	193	E1	51
ToD	Trabuco loam, 15 to 30 percent slopes	139	IVe-8 (18)	168	1	193	E1	45
[illegible]	Trabuco loam, 30 to 45 percent slopes	139	VIe-8 (18)	169	1	193	E9	24
[illegible]	Trabuco loam, 45 to 70 percent slopes	139	VIIe-1 (18)	170	1	193	E9	12
TpE	Trabuco very rocky loam, 30 to 45 percent slopes	139	VIs-8 (18)	170	1	193	E12	10
TpF	Trabuco very rocky loam, 45 to 70 percent slopes	140	VIIs-8 (18)	171	1	193	E12	5
Tr	Traver sandy loam	141	IIs-6 (17)	164	---	---	B1-2m	30
Ts	Traver sandy loam, moderately deep	141	IIs-6 (17)	164	---	---	B2-2m	34
Tt	Traver fine sandy loam	141	IIs-6 (17)	164	---	---	B1-2m	38
Tu	Traver fine sandy loam, moderately deep	141	IIs-6 (17)	164	---		B2-2m	30
TvC	Tretten fine sandy loam, 3 to 15 percent slopes	143	IIIe-8 (18)	165	1	193	E1	54
TvD	Tretten fine sandy loam, 15 to 30 percent slopes	143	IVe-8 (18)	168	1	193	E1	45
TvE	Tretten fine sandy loam, 30 to 45 percent slopes	143	VIe-8 (18)	169	1	193	E9	24
TvF	Tretten fine sandy loam, 45 to 70 percent slopes	143	VIIe-1 (18)	170	1	193	E9	11
TwF	Tretten very rocky fine sandy loam, 45 to 70 percent slopes	143	VIIs-8 (18)	171	1	193	E12	8
TxC	Trimmer loam, 3 to 15 percent slopes	145	IIIe-8 (18)	165	1	193	E1	58
TxD	Trimmer loam, 15 to 30 percent slopes	145	IVe-8 (18)	168	1	193	E1	49
TxE	Trimmer loam, 30 to 45 percent slopes	145	VIe-8 (18)	169	1	193	E9	24

Map symbol	Mapping unit	Described on page	Capability unit: Symbol	Capability unit: Page	Range site: Number	Range site: Page	Natural land type	Storie index rating
TxF	Trimmer loam, 45 to 70 percent slopes	145	VIIe-1 (18)	170	1	193	E9	11
TyE	Trimmer very rocky loam, 30 to 45 percent slopes	146	[illegible]	170	[illegible]	193	E12	18
TyF	Trimmer very rocky loam, 45 to 70 percent slopes	146	VIIs-8 (18)	171	1	193	E12	8
T_E	Trimmer-Tretten complex, 15 to 45 percent slopes	146	VIe-8 (18)	169	1	193	E9	30
TzF	Trimmer-Tretten complex, 45 to 70 percent slopes	146	[illegible]	[illegible]	1	[illegible]	E9	[illegible]
TzaA	Tujunga sand, 0 to 3 percent slopes	148	IVs-4 (17)	168	11	196	A5	54
TzbA	Tujunga loamy sand, 0 to 3 percent slopes	147	IIIs-4 (17)	166	---	---	A5	76
TzbB	Tujunga loamy sand, 3 to 9 percent slopes	148	IIIs-4 (17)	166	---	---	A5	68
TzcA	Tujunga loamy sand, gravelly substratum, 0 to 3 percent slopes	148	IVs-4 (17)	168	---	---	A5	62
TzdA	Tujunga cobbly loamy sand, 0 to 3 percent slopes	148	IVs-4 (17)	168	---	---	A7	38
TzeB	Tujunga soils, channeled, 0 to 9 percent slopes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
VaA	Visalia sandy loam, 0 to 3 percent slopes	149	I-1 (17, 18)	163	---	---	A1	95
VaB	Visalia sandy loam, 3 to 9 percent slopes	150	IIe-1 (17, 18)	163	---	---	A1	86
VdA	Visalia sandy loam, clay loam substratum, 0 to 3 percent slopes	150	I-1 (17, 18)	163	---	---	A2	81
VeA	Visalia loam, 0 to 3 percent slopes	150	I-1 (17, 18)	163	---	---	A1	95
VfB	Vista coarse sandy loam, 3 to 9 percent slopes	152	IIIe-8 (18)	165	6	195	E3	41
VfC	Vista coarse sandy loam, 9 to 15 percent slopes	152	IVe-8 (18)	168	6	195	E3	37
VfD	Vista coarse sandy loam, 15 to 30 percent slopes	[illegible]	VIe-1 (17, 18)	168	6	195	E3	34
VfE	Vista coarse sandy loam, 30 to 45 percent slopes	[illegible]	VIIe-1 (18)	170	6	195	E11	16
VfF	Vista coarse sandy loam, 45 to 70 percent slopes	[illegible]	VIIe-1 (18)	170	6	195	E11	9
VgB	Vista coarse sandy loam, shallow, 3 to 9 percent slopes	153	IVe-8 (18)	168	7	195	E7	28
VgD	Vista coarse sandy loam, shallow, 9 to 30 percent slopes	152	VIs-41 (18)	169	7	195	E7	24
VgF	Vista coarse sandy loam, shallow, 30 to 45 percent slopes	153	VIIe-4 (18)	170	7	195	E15	12
VkD	Vista very rocky coarse sandy loam, 3 to 30 percent slopes	153	VIs-1 (18)	169	6	195	E4	27
VkE	Vista very rocky coarse sandy loam, 30 to 45 percent slopes	153	VIIs-8 (18)	171	6	195	E12	14
VkF	Vista very rocky coarse sandy loam, 45 to 70 percent slopes	153	VIIs-8 (18)	171	6	195	E12	7
VlD	Vista very rocky coarse sandy loam, shallow, 3 to 30 percent slopes	154	VIs-41 (18)	169	7	195	E8	18
VlF	Vista very rocky coarse sandy loam, shallow, 30 to 70 percent slopes	154	VIIs-8 (18)	171	7	195	E16	7
VmD	Vista extremely rocky coarse sandy loam, 3 to 30 percent slopes	154	VIIs-7 (17, 18)	170	10	196	E8	14
VnD	Vista-Fallbrook coarse sandy loams, 9 to 30 percent slopes	154	VIe-41 (18)	169	7	195	E7	19
VoD	Vista-Fallbrook very rocky coarse sandy loams, 3 to 30 percent slopes	154	VIs-1 (18)	169	6	195	E4	30
VoE	Vista-Fallbrook very rocky coarse sandy loams, 30 to 45 percent slopes	155	VIIs-8 (18)	171	6	195	E12	15
VsF	Vista-Fallbrook extremely rocky coarse sandy loams, 30 to 70 percent slopes	155	VIIs-7 (17, 18)	170	10	196	E16	5
Wa	Waukena fine sandy loam	156	IVs-6 (17)	168	---	---	B9-2a	16

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Range site		Natural land type	Storie index rating
			Symbol	Page	Number	Page		
We	Waukena loam----------------------------------	156	IVs-6 (17)	168	---	---	B9-2a	11
WhB	Wishevlu loam, 3 to 9 percent slopes---	156	IIIe-6 (18)	[illegible]	1	193	F1	60
WhD	Wishevlu loam, 9 to 30 percent slopes---	158	IVe-8 (18)	168	1	193	[illegible]	30
WhE	Wishevlu loam, 30 to 45 percent slopes	158	VIe-6 (18)	169	1	193	F9	15
WhF	Wishevlu loam, 45 to 70 percent slopes	157	VIIe-1 (18)	[illegible]	1	193	F9	15
WrD	Wishevlu very rocky loam, 3 to 30 percent slopes---------	158	VIs-9 (18)	170	1	193	F4	32
Ws	Womack fine sandy loam---	159	[illegible]	164		---	B1-2a	60
Wt	Womack silt loam--------------	159	IIe-6 (17)	164	-		B1-2a	63
YhA	Yokohl loam, 0 to 3 percent slopes	160	IIIs-8 (17)	167	8	195	C13	24
YhB	Yokohl loam, 3 to 9 percent slopes------	160	IIIe-8 (17)	165	8	195	C13	[illegible]
YkA	Yokohl loam, moderately deep, 0 to 3 percent slopes---	161	IIIs-8 (17)	16	8	195	C13	38
YkB	Yokohl loam, moderately deep, 3 to 9 percent slopes------	161	IIIe-8 (17)	165	8	195	C13	34
YlB	Yokohl gravelly loam, 3 to 9 percent slopes--	161	IIIe-8 (17)	165	8	195	C16	[illegible]
YmA	Yokohl clay loam, moderately deep, 0 to 3 percent slopes------------------------------	161	IIIs-8 (17)	167	8	195	C13	32

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SOIL ASSOCIATIONS

SOILS OF THE VALLEY BASIN

POORLY DRAINED SOILS OF THE BASIN FLOOD PLAIN

- Merced-Temple association: Deep and very deep clay loams and clays

SOMEWHAT EXCESSIVELY DRAINED TO POORLY DRAINED SOILS OF THE BASIN RIM

- Ross-Waukena association: Deep, somewhat poorly drained and poorly drained, dominantly fine sandy loams that are saline-alkali
- Fresno-El Peco association: Somewhat poorly drained fine sandy loams that are saline-alkali and that are shallow or moderately deep to a hardpan
- Traver-Calhi association: Somewhat poorly drained to somewhat excessively drained fine sandy loams to loamy sands that are saline-alkali and that are moderately deep or deep to compact silt

SOILS OF THE EASTSIDE VALLEY ALLUVIAL PLAINS

EXCESSIVELY DRAINED TO SOMEWHAT POORLY DRAINED SOILS OF RECENT ALLUVIAL FANS AND FLOOD PLAINS

- 5 Grangeville-Chino association: Deep and very deep, somewhat poorly drained sandy loams to loams
- Hanford-Tujunga association: Deep, well-drained to excessively drained, dominantly loamy sands to fine sandy loams

SOMEWHAT EXCESSIVELY DRAINED TO MODERATELY WELL DRAINED SOILS OF YOUNG ALLUVIAL FANS

- Hanford-Hesperia association: Well-drained sandy loams and fine sandy loams that are moderately deep or deep to compact silt
- Hanford-Delhi-Hesperia association: Deep, somewhat excessively drained and well-drained sands to fine sandy loams, partly wind modified
- 9 Pachappa-Hesperia association: Well drained and moderately well drained fine sandy loams or loams that are moderately deep or deep to compact silt
- 10 Greenfield-Atwater association: Well-drained loamy sands and sandy loams that are moderately deep or deep to compact sandy material, partly wind modified

WELL-DRAINED SOILS OF LOW ALLUVIAL TERRACES

- San Joaquin-Exeter-Ramona association: Sandy loams to loams that are shallow or moderately deep to a hardpan and deep sandy loams and loams
- Academy-Yokohl association: Loams that are moderately deep to a compact layer and soils of similar texture that are shallow to a cemented hardpan

WELL-DRAINED SOILS OF HIGH ALLUVIAL TERRACES

- Centerville-Keyes association: Clays that are moderately deep to compact sandy material and cobbly clay loams that are shallow to a cemented hardpan
- Positas-Redding association: Gravelly loams that are moderately deep to a compact layer or a cemented hardpan

SOILS OF THE UPLANDS OF THE SIERRA NEVADA FOOTHILLS

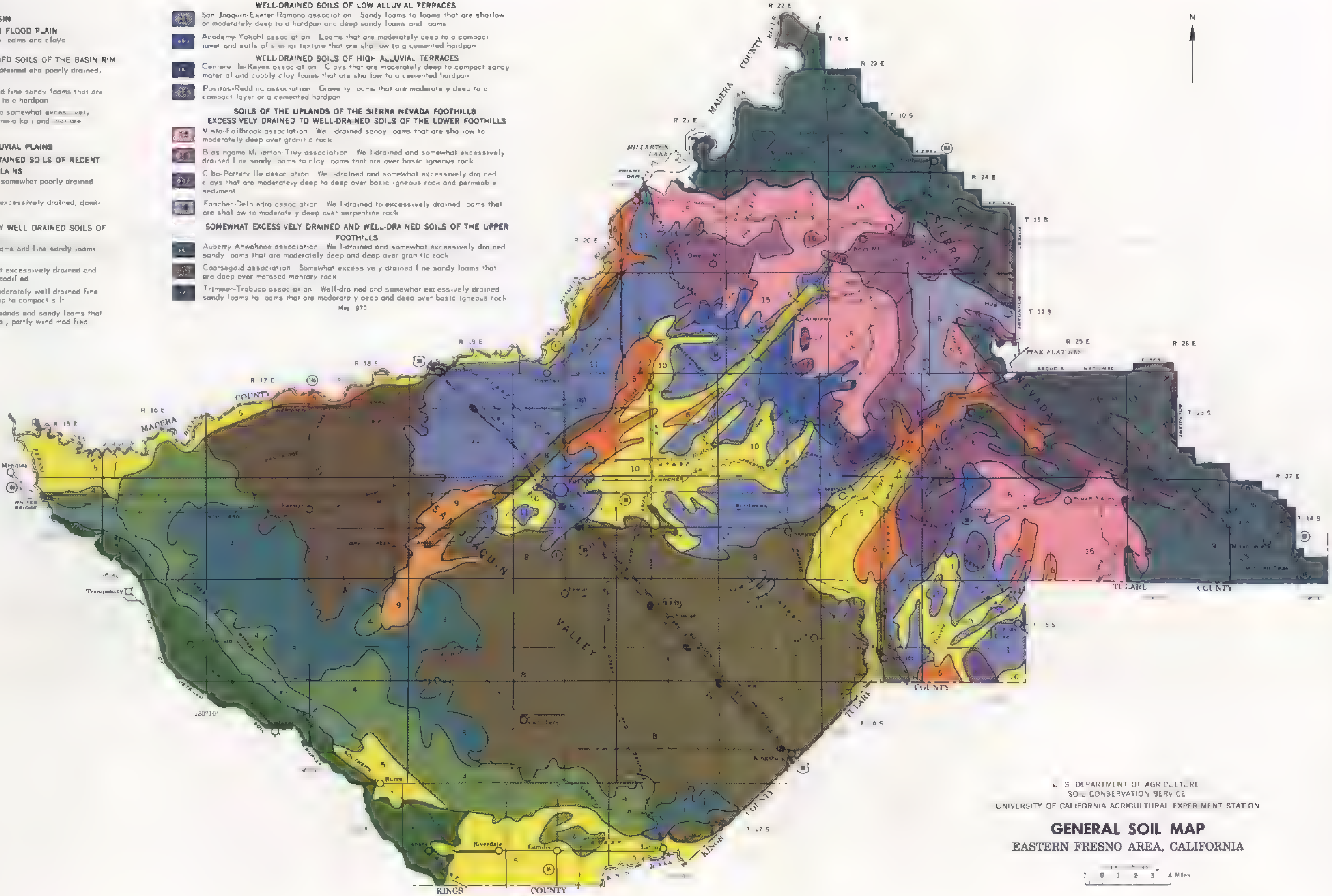
EXCESSIVELY DRAINED TO WELL-DRAINED SOILS OF THE LOWER FOOTHILLS

- Vista-Fallbrook association: Well-drained sandy loams that are shallow to moderately deep over granitic rock
- Blasingame-Millerton-Tivy association: Well-drained and somewhat excessively drained fine sandy loams to clay loams that are over basic igneous rock
- Cibo-Porterville association: Well-drained and somewhat excessively drained clays that are moderately deep to deep over basic igneous rock and permeable sediment
- Fancher-Delpiedra association: Well-drained to excessively drained loams that are shallow to moderately deep over serpentine rock

SOMEWHAT EXCESSIVELY DRAINED AND WELL-DRAINED SOILS OF THE UPPER FOOTHILLS

- Auberry-Ahwahnee association: Well-drained and somewhat excessively drained sandy loams that are moderately deep and deep over granitic rock
- Coarsegold association: Somewhat excessively drained fine sandy loams that are deep over metasedimentary rock
- Trimmer-Trabuco association: Well-drained and somewhat excessively drained sandy loams to loams that are moderately deep and deep over basic igneous rock

May 1970

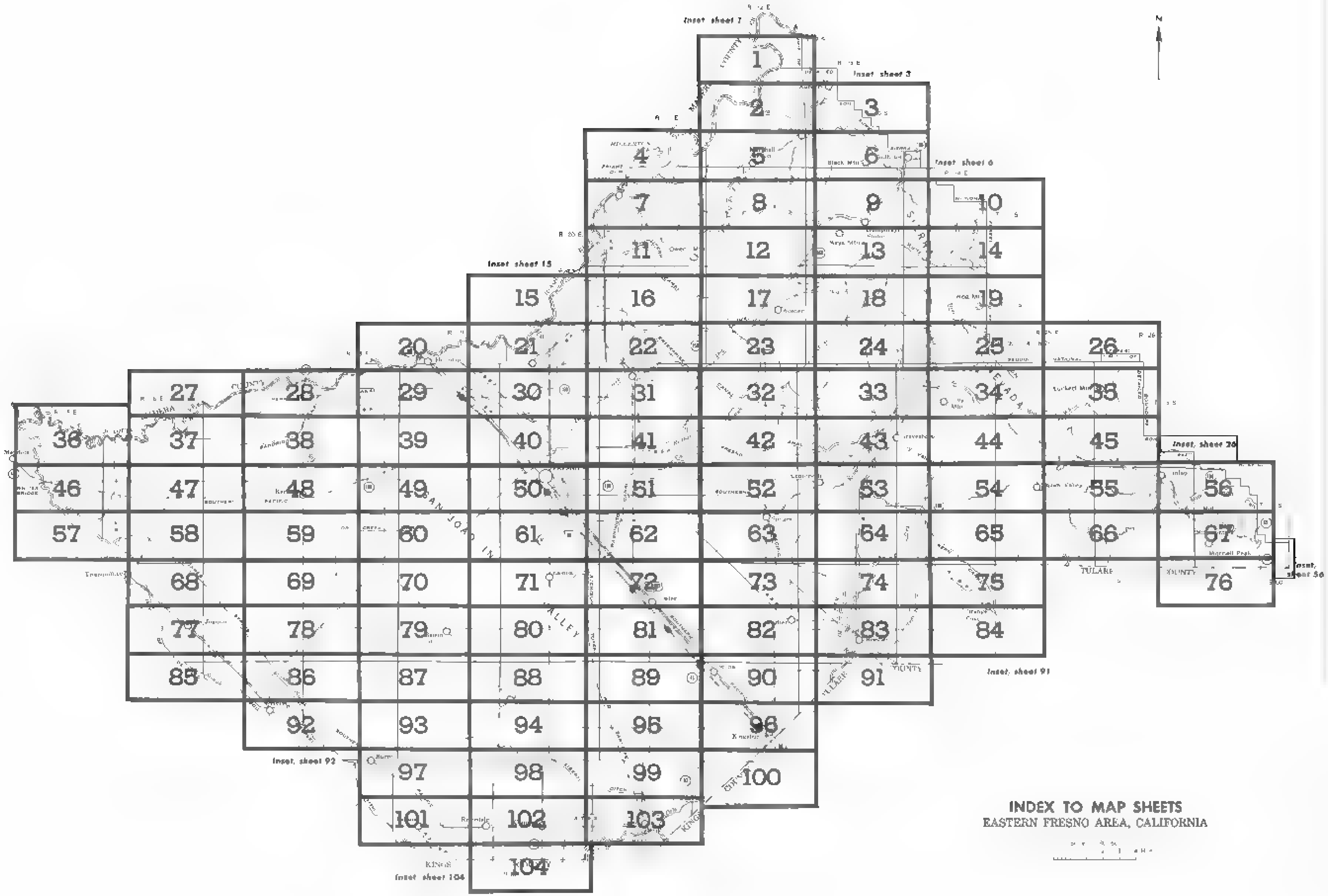


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
UNIVERSITY OF CALIFORNIA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
EASTERN FRESNO AREA, CALIFORNIA

1 0 1 2 3 4 Miles

NOTE
This map is intended for general planning. Each delineation may contain soils having ratings different from those shown on the map. Use detailed soil maps for operational planning.



INDEX TO MAP SHEETS
EASTERN FRESNO AREA, CALIFORNIA

EASTERN FRESNO AREA, CALIFORNIA

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads

- Dual
- Good motor
- [illegible]
- Trail

Highway markers

- National Interstate
- State or county

Railroads

- Single track
- Multiple track
- Abandoned

Bridges and crossings

- Road
- Trail
- Railroad
- Ferry
- Ford
- Grade
- R. R. over
- R. R. under

Tunnel

Buildings

- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

BOUNDARIES

- National or state
- County
- Project area
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line

- Perennial
- Intermittent

Streams, single-line

- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
- Unclassified

Canals and ditches

CANAL

Lakes and ponds

- Perennial

water

- Intermittent

Spring

Marsh or swamp

Wet spot

Alluvial fan

Drainage end

RELIEF

Escarpments

- Bedrock
- Other

Prominent peak

Depressions

	Large	Small
Crossable with tillage implements		
Not crossable with tillage implements		
Contains water most of the time		

SOIL SURVEY DATA

- Soil boundary
- [illegible]
- [illegible]
- [illegible]
- Rock outcrop
- Chert fragments
- Clay spot
- Sand spot
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- Gully
- Kitchen midden
- Saline spot

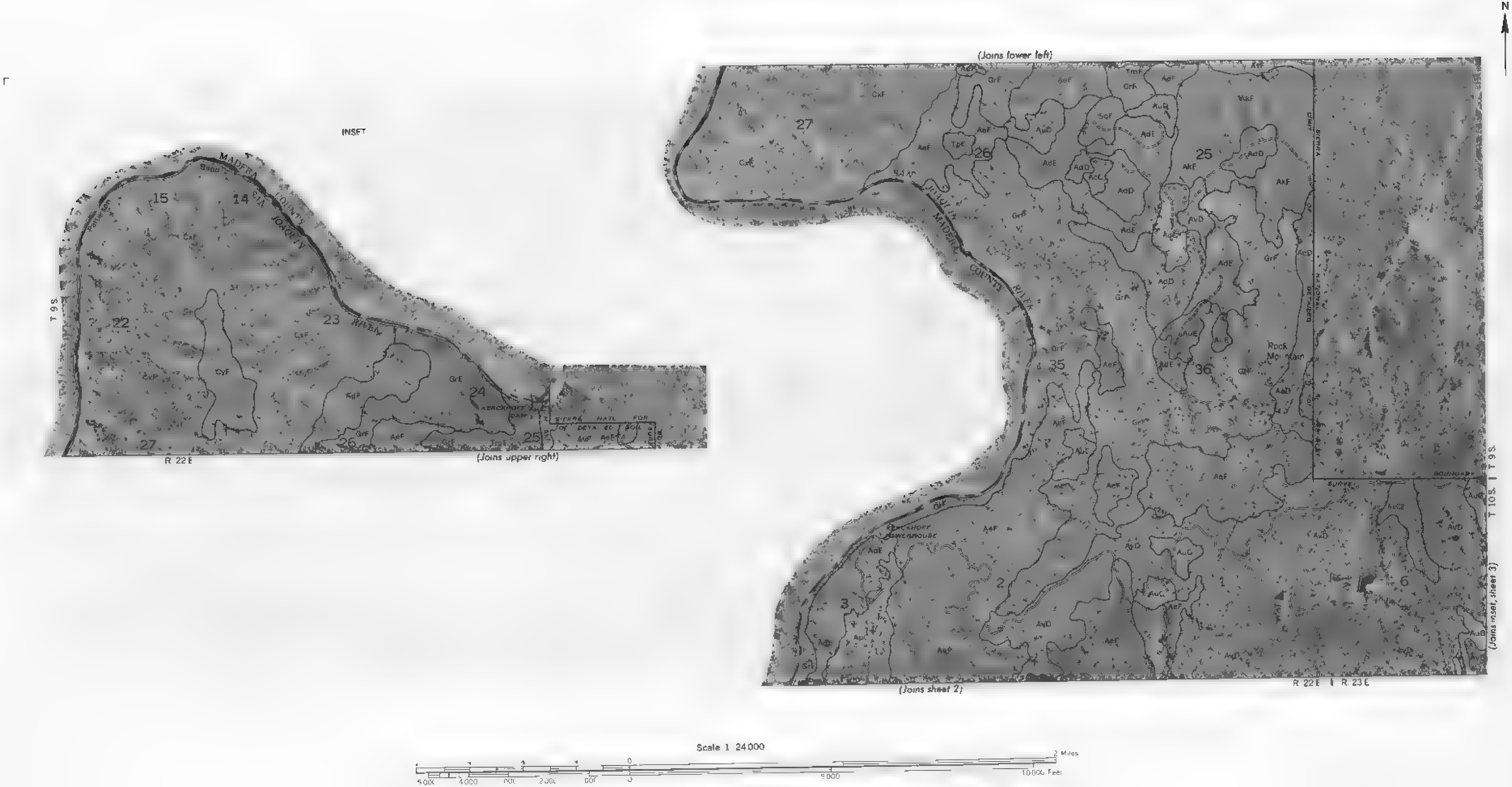
SOIL LEGEND

Each symbol consists of letters or a combination of letters and numbers. The first capital letter is the initial one of the soil name. A second capital letter, if used, shows the class of slope. Soils for which no slope letter is shown are nearly level. A final number 2 in a symbol shows that the soil is eroded.

SYMBOL	NAME
AgA	Academy loam, 0 to 3 percent slopes
AgB	Academy loam, 3 to 9 percent slopes
AhB	Ahwahnee coarse sandy loam, 3 to 9 percent slopes
AhC	Ahwahnee coarse sandy loam, 9 to 15 percent slopes
AhD	Ahwahnee coarse sandy loam, 15 to 30 percent slopes
AhE	Ahwahnee coarse sandy loam, 30 to 45 percent slopes
AoD	Ahwahnee very rocky coarse sandy loam, 3 to 30 percent slopes
AoE	Ahwahnee very rocky coarse sandy loam, 30 to 45 percent slopes
AoF	Ahwahnee very rocky coarse sandy loam, 45 to 70 percent slopes
AeD	Ahwahnee very rocky coarse sandy loam, shallow, 3 to 30 percent slopes
AeF	Ahwahnee very rocky coarse sandy loam, shallow, 30 to 70 percent slopes
AhD	Ahwahnee-Sierra coarse sandy loams, 15 to 30 percent slopes
AhE	Ahwahnee-Sierra coarse sandy loams, 30 to 45 percent slopes
AkF	Ahwahnee-Tollhouse-Rock land complex, 45 to 70 percent slopes
AlB	Aiken loam, 3 to 9 percent slopes
AmF	Aiken very rocky loam, 45 to 70 percent slopes
Ar	Alamo clay
AsA	Atwater loamy sand, 0 to 3 percent slopes
AsB	Atwater loamy sand, 3 to 9 percent slopes
ApA	Atwater loamy sand, moderately deep, 0 to 3 percent slopes
AtA	Atwater sandy loam, 0 to 3 percent slopes
AtB	Atwater sandy loam, 3 to 9 percent slopes
AsA	Atwater sandy loam, clay substratum, 0 to 3 percent slopes
AtA	Atwater sandy loam, moderately deep, 0 to 3 percent slopes
AuB	Auberry coarse sandy loam, 3 to 9 percent slopes
AuB2	Auberry coarse sandy loam, 3 to 9 percent slopes, eroded
AuC	Auberry coarse sandy loam, 9 to 15 percent slopes
AuC2	Auberry coarse sandy loam, 9 to 15 percent slopes, eroded
AuD	Auberry coarse sandy loam, 15 to 30 percent slopes
AuD2	Auberry coarse sandy loam, 15 to 30 percent slopes, eroded
AuE	Auberry coarse sandy loam, 30 to 45 percent slopes
AuF	Auberry coarse sandy loam, 45 to 70 percent slopes
AvD	Auberry very rocky coarse sandy loam, 3 to 30 percent slopes
AvE	Auberry very rocky coarse sandy loam, 30 to 45 percent slopes
AvF	Auberry very rocky coarse sandy loam, 45 to 70 percent slopes
AwF	Auberry very rocky coarse sandy loam, shallow, 30 to 70 percent slopes
AxD	Auberry-Sierra coarse sandy loams, 15 to 30 percent slopes
AxE	Auberry-Sierra coarse sandy loams, 30 to 45 percent slopes
AxF	Auberry-Sierra coarse sandy loams, 45 to 70 percent slopes
AyF	Auberry-Sierra very rocky coarse sandy loams, 45 to 70 percent slopes
AzF	Auberry-Tollhouse-Rock land complex, 30 to 70 percent slopes
BaF	Basic igneous rock land
BcC	Blasingame loam, 3 to 15 percent slopes
BcD	Blasingame loam, 15 to 30 percent slopes
BcE	Blasingame loam, 30 to 45 percent slopes
BcF	Blasingame loam, 45 to 70 percent slopes
BdF	Blasingame loam, shallow, 45 to 70 percent slopes
BgD	Blasingame very rocky loam, 3 to 30 percent slopes
BgF	Blasingame very rocky loam, 45 to 70 percent slopes
BkF	Blasingame extremely rocky loam, shallow, 30 to 70 percent slopes
BlD	Blasingame clay loam, shallow, 9 to 30 percent slopes
BlE	Blasingame clay loam, shallow, 30 to 45 percent slopes
BmE	Blasingame very rocky clay loam, 30 to 45 percent slopes
Bn	Borden loam
Bs	Borden loam, saline-alkali
Bt	Borden loam, moderately deep
Bu	Borden loam, moderately deep, saline-alkali
Ca	Cajon loamy coarse sand
Cb	Cajon loamy coarse sand, saline-alkali
Cc	Cajon coarse sandy loam
Cd	Cajon coarse sandy loam, saline-alkali
Ce	Cajon coarse sandy loam, moderately deep, saline-alkali
CfA	Calhi loamy sand, 0 to 3 percent slopes
CfB	Calhi loamy sand, 3 to 9 percent slopes
CgA	Calhi loamy sand, moderately deep, 0 to 3 percent slopes
ChA	Centerville clay, 0 to 3 percent slopes
ChC	Centerville clay, 3 to 15 percent slopes
CkB	Centerville cobbly clay, 3 to 9 percent slopes
CkD	Centerville cobbly clay, 9 to 30 percent slopes
Cl	China sandy loam
Cm	China sandy loam, saline-alkali
Cn	China fine sandy loam
Co	China fine sandy loam, saline-alkali
Cp	China fine sandy loam, moderately deep, saline-alkali
Cr	China loam
Cs	China loam, saline-alkali
CtA	Chualar sandy loam, 0 to 3 percent slopes
CtB	Chualar sandy loam, 3 to 9 percent slopes
CuC	Cibo clay, 3 to 15 percent slopes
CuD	Cibo clay, 15 to 30 percent slopes
CuE	Cibo clay, 30 to 45 percent slopes
CvD	Cibo very rocky clay, 3 to 30 percent slopes
CvE	Cibo very rocky clay, 30 to 45 percent slopes
CvF	Cibo very rocky clay, 45 to 70 percent slopes
CwD	Cibo extremely rocky clay, 3 to 30 percent slopes
CwE	Cibo extremely rocky clay, 30 to 45 percent slopes
CxC	Coarsegold fine sandy loam, 9 to 15 percent slopes
CxD	Coarsegold fine sandy loam, 15 to 30 percent slopes
CxE	Coarsegold fine sandy loam, 30 to 45 percent slopes
CxF	Coarsegold fine sandy loam, 45 to 70 percent slopes
CyF	Coarsegold rocky fine sandy loam, 45 to 70 percent slopes
CzF	Colluvial land
CzaB	Cometa sandy loam, 3 to 9 percent slopes
CzaC	Cometa sandy loam, 9 to 15 percent slopes
CzaD	Cometa sandy loam, 15 to 30 percent slopes
CzbB	Cometa loam, 2 to 9 percent slopes
CzcB	Cometa-San Joaquin sandy loams, 3 to 9 percent slopes
DeA	Delhi sand, 0 to 3 percent slopes
DeB	Delhi sand, 3 to 9 percent slopes
DhA	Delhi loamy sand, 0 to 3 percent slopes
DhB	Delhi loamy sand, 3 to 9 percent slopes
DkA	Delhi loamy sand, moderately deep, 0 to 3 percent slopes
Dm	Dello loamy sand
Dn	Dello sandy loam
DpE	Delpiedra extremely stony loam, 30 to 45 percent slopes
DpF	Delpiedra extremely stony loam, 45 to 70 percent slopes
DsF	Delpiedra-Fancher extremely stony loams, 45 to 70 percent slopes
Er	El Peco sandy loam
Ed	El Peco fine sandy loam
Ep	El Peco loam
Es	Exeter sandy loam
Et	Exeter sandy loam, shallow
Ex	Exeter loam
FaB	Fallbrook sandy loam, 3 to 9 percent slopes
FaC	Fallbrook sandy loam, 9 to 15 percent slopes
FaD	Fallbrook sandy loam, 15 to 30 percent slopes
FaE	Fallbrook sandy loam, 30 to 45 percent slopes
FbB	Fallbrook sandy loam, shallow, 3 to 9 percent slopes
FbD	Fallbrook sandy loam, shallow, 9 to 30 percent slopes
FcD	Fallbrook very rocky sandy loam, 3 to 30 percent slopes
FcF	Fallbrook very rocky sandy loam, 30 to 70 percent slopes
FdD	Fallbrook very rocky sandy loam, shallow, 3 to 30 percent slopes
FdF	Fallbrook very rocky sandy loam, shallow, 30 to 70 percent slopes
FeF	Fallbrook extremely rocky sandy loam, 30 to 45 percent slopes
FhE	Fancher extremely stony loam, 30 to 45 percent slopes
FhF	Fancher extremely stony loam, 45 to 70 percent slopes
FkE	Fancher-Blasingame complex, 30 to 45 percent slopes
FkF	Fancher-Blasingame complex, 45 to 70 percent slopes
Fm	Foster sandy loam
Fn	Foster loam
Fo	Foster loam, saline-alkali
Fp	Foster loam, moderately deep
Fr	Foster loam, moderately deep, saline-alkali
Fs	Fresno sandy loam
Ft	Fresno sandy loam, shallow
Fu	Fresno fine sandy loam
Fv	Fresno fine sandy loam, shallow
Fw	Fresno clay loam
Fx	Fresno-Traver complex
FyD	Friant fine sandy loam, 9 to 30 percent slopes
FyE	Friant fine sandy loam, 30 to 45 percent slopes
Ga	Grangeville sandy loam
Gd	Grangeville sandy loam, saline-alkali
Ge	Grangeville sandy loam, sandy substratum
Gf	Grangeville fine sandy loam
Gg	Grangeville fine sandy loam, saline-alkali
Gh	Grangeville fine sandy loam, water table
Gk	Grangeville fine sandy loam, water table, saline-alkali
Gl	Grangeville fine sandy loam, gravelly substratum
Gm	Grangeville fine sandy loam, sandy substratum
Gr	Grangeville fine sandy loam, hard substratum
Gs	Grangeville fine sandy loam, hard substratum, saline-alkali
Gt	Grangeville soils, channeled
GrF	Granitic rock land
GsA	Greenfield coarse sandy loam, 0 to 3 percent slopes
GtA	Greenfield sandy loam, 0 to 3 percent slopes
GtB	Greenfield sandy loam, 3 to 9 percent slopes
GuA	Greenfield sandy loam, moderately deep, 0 to 3 percent slopes
Ha	Hanford coarse sandy loam
Hb	Hanford coarse sandy loam, hard substratum
Hc	Hanford sandy loam
Hd	Hanford sandy loam, benches
He	Hanford sandy loam, gravelly substratum
Hf	Hanford sandy loam, sandy substratum
Hg	Hanford sandy loam, silty substratum
Hh	Hanford sandy loam, clay loam substratum
Hk	Hanford sandy loam, hard substratum
Hl	Hanford gravelly sandy loam
Hm	Hanford fine sandy loam
Hn	Hanford fine sandy loam, gravelly substratum
Ho	Hanford fine sandy loam, silty substratum
Hp	Hanford fine sandy loam, clay loam substratum
Hr	Hanford fine sandy loam, hard substratum
Hsa	Hesperia coarse sandy loam
Hsc	Hesperia coarse sandy loam, saline-alkali
Hsd	Hesperia sandy loam
Hse	Hesperia sandy loam, saline-alkali
Hsm	Hesperia sandy loam, moderately deep
Hsn	Hesperia sandy loam, moderately deep, saline-alkali
Hso	Hesperia sandy loam, shallow
Hsp	Hesperia sandy loam, shallow, saline-alkali
Hsr	Hesperia fine sandy loam
Hss	Hesperia fine sandy loam, saline-alkali
Hst	Hesperia fine sandy loam, moderately deep
Hsy	Hesperia fine sandy loam, moderately deep, saline-alkali
HtC	Hideaway extremely stony loam, 3 to 15 percent slopes
Hu	Hildreth clay
HvE	Holland coarse sandy loam, 15 to 45 percent slopes
HwA	Honcut fine sandy loam, 0 to 3 percent slopes
HwB	Honcut fine sandy loam, 3 to 9 percent slopes
HyA	Honcut fine sandy loam, gravelly substratum, 0 to 3 percent slopes
HzA	Honcut fine sandy loam, hard substratum, 0 to 3 percent slopes
KeC	Keefers loam, 3 to 15 percent slopes
KfD	Keefers cobbly loam, 3 to 30 percent slopes
KmC	Kayes cobbly clay loam, 3 to 15 percent slopes
LbB	Los Robles sandy loam, 2 to 9 percent slopes
LgB	Los Robles sandy loam, gravelly substratum, 2 to 9 percent slope
LmA	Los Robles loam, 0 to 3 percent slopes
LmB	Los Robles loam, 3 to 9 percent slopes
LnB	Los Robles loam, hard substratum, 2 to 9 percent slopes
LoA	Los Robles clay loam, 0 to 3 percent slopes
Ma	Madera sandy loam
Mc	Madera loam
Md	Madera loam, saline-alkali
Me	Madera clay loam
Mf	Merced clay loam
Mg	Merced clay loam, slightly saline
Mh	Merced clay
Mk	Merced clay, slightly saline
Ml	Merced clay, moderately saline
Mm	Merced clay, saline-alkali
MnD	Millerton fine sandy loam, 9 to 30 percent slopes
MnE	Millerton fine sandy loam, 30 to 45 percent slopes
MnF	Millerton fine sandy loam, 45 to 70 percent slopes
MnF2	Millerton fine sandy loam, 45 to 70 percent slopes, eroded
MoD	Millerton rocky fine sandy loam, 3 to 30 percent slopes
MoE	Millerton very rocky fine sandy loam, 30 to 45 percent slopes
MoF	Millerton very rocky fine sandy loam, 45 to 70 percent slopes
MpC	Montpellier coarse sandy loam, 9 to 15 percent slopes
MpD	Montpellier coarse sandy loam, 15 to 30 percent slopes
MrB	Mt. Olive clay, 3 to 9 percent slopes
MrC	Mt. Olive clay, 9 to 15 percent slopes
No	Nord loam
Ns	Nord loam, saline-alkali
Pa	Pachappa loam
Pc	Pachappa loam, saline-alkali
Pd	Pachappa loam, moderately deep
Pe	Pachappa loam, moderately deep, saline-alkali
PfB	Piper sandy loam, 0 to 9 percent slopes
PgB	Piper fine sandy loam, 0 to 9 percent slopes
PhB	Piper-Rossi complex, 0 to 9 percent slopes
Pk	Pits
Pl	Playas
PmB	Pollasky sandy loam, 2 to 9 percent slopes
PmC	Pollasky sandy loam, 9 to 15 percent slopes
PmD	Pollasky sandy loam, 15 to 30 percent slopes
PnB	Pollasky fine sandy loam, 2 to 9 percent slopes
PnC	Pollasky fine sandy loam, 9 to 15 percent slopes
PoC	Pollasky-Montpellier complex, 9 to 15 percent slopes
PoD	Pollasky-Montpellier complex, 15 to 30 percent slopes
PpC	Pollasky-Rocklin sandy loams, 3 to 15 percent slopes
Pr	Pond sandy loam
Ps	Pond sandy loam, moderately deep
Pt	Pond fine sandy loam
Pu	Pond fine sandy loam, moderately deep
Pv	Pond loam
Pw	Pond loam, moderately deep
PxA	Porterville clay, 0 to 3 percent slopes
PxC	Porterville clay, 3 to 15 percent slopes
PyC	Porterville cobbly clay, 3 to 15 percent slopes
PzD	Porterville very cobbly clay, 0 to 30 percent slopes
PzaB	Positas gravelly loam, 3 to 9 percent slopes
PzaD	Positas gravelly loam, 9 to 30 percent slopes
PzaE	Positas gravelly loam, 30 to 45 percent slopes
Ra	Ramona sandy loam
Rb	Ramona sandy loam, hard substratum
Rc	Ramona loam
Rd	Ramona loam, gravelly substratum
Re	Ramona loam, hard substratum
RfC	Redding gravelly loam, 3 to 15 percent slopes
RgB	Redding gravelly loam, shallow, 0 to 9 percent slopes
Rh	Riverwash
RkB	Rocklin sandy loam, 3 to 9 percent slopes
RlD	Rocklin sandy loam, pumiceous variant, 3 to 30 percent slopes
Ro	Rossi fine sandy loam
Rs	Rossi clay loam
Sa	Sandy alluvial land
Sb	Sandy alluvial land, leveled
ScA	San Joaquin sandy loam, 0 to 3 percent slopes
SdA	San Joaquin sandy loam, shallow, 0 to 3 percent slopes
SdB	San Joaquin sandy loam, shallow, 3 to 9 percent slopes
SeA	San Joaquin loam, 0 to 3 percent slopes
SfA	San Joaquin loam, gravelly substratum, 0 to 3 percent slopes
SgA	San Joaquin loam, shallow, 0 to 3 percent slopes
SgB	San Joaquin loam, shallow, 3 to 9 percent slopes
ShB	San Joaquin-Alamo complex, 3 to 9 percent slopes
SkB	Sesame sandy loam, 3 to 9 percent slopes
SkC	Sesame sandy loam, 9 to 15 percent slopes
SkD	Sesame sandy loam, 15 to 30 percent slopes
SlB	Sesame loam, 3 to 9 percent slopes
SlC	Sesame loam, 9 to 15 percent slopes
SmE	Shaver coarse sandy loam, 15 to 45 percent slopes
SnC	Sierra sandy loam, 9 to 15 percent slopes
SnD	Sierra sandy loam, 15 to 30 percent slopes
SnE	Sierra sandy loam, 30 to 45 percent slopes
SnF	Sierra sandy loam, 45 to 70 percent slopes
SoD	Sierra very rocky sandy loam, 3 to 30 percent slopes
SoE	Sierra very rocky sandy loam, 30 to 45 percent slopes
SoF	Sierra very rocky sandy loam, 45 to 70 percent slopes
StF	Sierra-Tollhouse-Rock land complex, 45 to 70 percent slopes
Sw	Swamp
Ta	Temple loam
Tb	Temple loam, saline
Tc	Temple loam, saline-alkali
Td	Temple clay loam
Te	Temple clay loam, saline
Tf	Temple clay loam, saline-alkali
Tg	Temple clay
ThF	Terrace escarpments
TkB	Tivy loam, 3 to 9 percent slopes
TkD	Tivy loam, 9 to 30 percent slopes
TkE	Tivy loam, 30 to 45 percent slopes
TkF	Tivy loam, 45 to 70 percent slopes
TlD	Tivy very rocky loam, 3 to 30 percent slopes
TlF	Tivy very rocky loam, 30 to 70 percent slopes
TmF	Tollhouse extremely rocky coarse sandy loam, 30 to 70 percent slopes
TnF	Toomes extremely cobbly loam, 30 to 70 percent slopes
ToC	Trabuco loam, 9 to 15 percent slopes
ToD	Trabuco loam, 15 to 30 percent slopes
ToE	Trabuco loam, 30 to 45 percent slopes
ToF	Trabuco loam, 45 to 70 percent slopes
TpE	Trabuco very rocky loam, 30 to 45 percent slopes
TpF	Trabuco very rocky loam, 45 to 70 percent slopes
Tr	Traver sandy loam
Ts	Traver sandy loam, moderately deep
Tt	Traver fine sandy loam
Tu	Traver fine sandy loam, moderately deep
TvC	Tretten fine sandy loam, 3 to 15 percent slopes
TvD	Tretten fine sandy loam, 15 to 30 percent slopes
TvE	Tretten fine sandy loam, 30 to 45 percent slopes
TvF	Tretten fine sandy loam, 45 to 70 percent slopes
TwF	Tretten very rocky fine sandy loam, 45 to 70 percent slopes
TxC	Trimmer loam, 3 to 15 percent slopes
TxD	Trimmer loam, 15 to 30 percent slopes
TxE	Trimmer loam, 30 to 45 percent slopes
TxF	Trimmer loam, 45 to 70 percent slopes
TyE	Trimmer very rocky loam, 30 to 45 percent slopes
TyF	Trimmer very rocky loam, 45 to 70 percent slopes
TzE	Trimmer-Tretten complex, 15 to 45 percent slopes
TzF	Trimmer-Tretten complex, 45 to 70 percent slopes
TzaA	Tujunga sand, 0 to 3 percent slopes
TzbA	Tujunga loamy sand, 0 to 3 percent slopes
TzbB	Tujunga loamy sand, 3 to 9 percent slopes
TzcA	Tujunga loamy sand, gravelly substratum, 0 to 3 percent slopes
TzdA	Tujunga cobbly loamy sand, 0 to 3 percent slopes
TzeB	Tujunga soils, channeled, 0 to 9 percent slopes
VaA	Visalia sandy loam, 0 to 3 percent slopes
VaB	Visalia sandy loam, 3 to 9 percent slopes
VdA	Visalia sandy loam, clay loam substratum, 0 to 3 percent slopes
VeA	Visalia loam, 0 to 3 percent slopes
VfB	Vista coarse sandy loam, 3 to 9 percent slopes
VfC	Vista coarse sandy loam, 9 to 15 percent slopes
VfD	Vista coarse sandy loam, 15 to 30 percent slopes
VfE	Vista coarse sandy loam, 30 to 45 percent slopes
VfF	Vista coarse sandy loam, 45 to 70 percent slopes
VgB	Vista coarse sandy loam, shallow, 3 to 9 percent slopes
VgD	Vista coarse sandy loam, shallow, 9 to 30 percent slopes
VgE	Vista coarse sandy loam, shallow, 30 to 45 percent slopes
VkD	Vista very rocky coarse sandy loam, 3 to 30 percent slopes
VkE	Vista very rocky coarse sandy loam, 30 to 45 percent slopes
VkF	Vista very rocky coarse sandy loam, 45 to 70 percent slopes
VlD	Vista very rocky coarse sandy loam, shallow, 3 to 30 percent slopes
VlF	Vista very rocky coarse sandy loam, shallow, 30 to 70 percent slopes
VmD	Vista extremely rocky coarse sandy loam, 3 to 30 percent slopes
VnD	Vista-Fallbrook coarse sandy loams, 9 to 30 percent slopes
VoD	Vista-Fallbrook very rocky coarse sandy loams, 3 to 30 percent slopes
VoE	Vista-Fallbrook very rocky coarse sandy loams, 30 to 45 percent slopes
VsF	Vista-Fallbrook extremely rocky coarse sandy loams, 30 to 70 percent slopes
Wa	Waukena fine sandy loam
We	Waukena loam
WhB	Wisheylu loam, 3 to 9 percent slopes
WhD	Wisheylu loam, 9 to 30 percent slopes
WhE	Wisheylu loam, 30 to 45 percent slopes
WhF	Wisheylu loam, 45 to 70 percent slopes
WrD	Wisheylu very rocky loam, 3 to 30 percent slopes
Ws	Wunjey fine sandy loam
Wu	Wunjey silt loam
YhA	Yokohl loam, 0 to 3 percent slopes
YhB	Yokohl loam, 3 to 9 percent slopes
YkA	Yokohl loam, moderately deep, 0 to 3 percent slopes
YkB	Yokohl loam, moderately deep, 3 to 9 percent slopes
YlB	Yokohl gravelly loam, 3 to 9 percent slopes
YmA	Yokohl clay loam, moderately deep, 0 to 3 percent slopes

Soil map constructed 1968 by Cartographic Division, Soil Conservation Service, USDA, from 1957 and 1962 aerial photographs. Controlled mosaic based on California plane coordinate system, fourth zone, Lambert conformal conic projection, 1927 North American datum.

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 1



This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 2

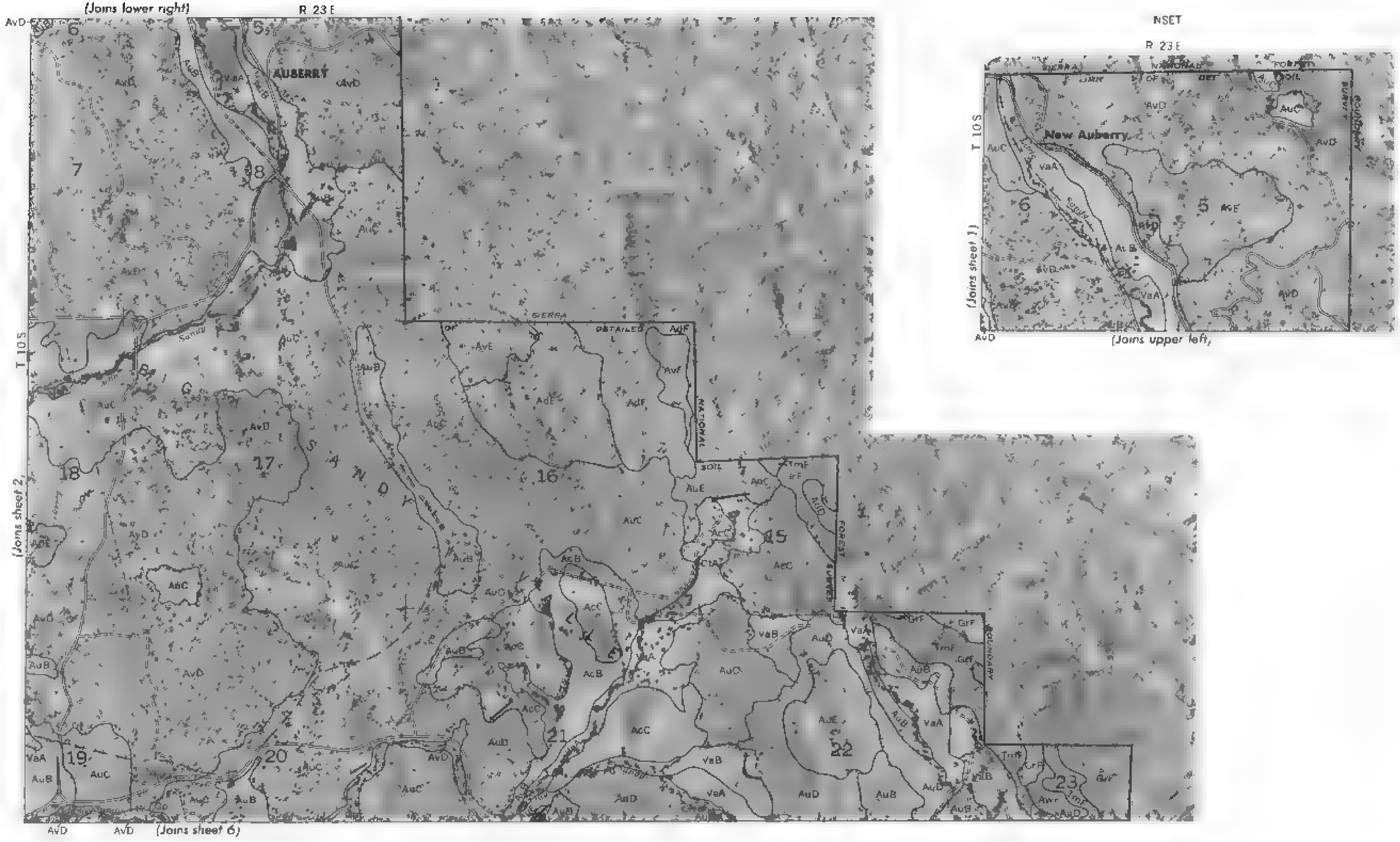
Scale 1:24000

EASTERN FRESNO AREA, CALIFORNIA NO. 2

Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station

N



Scale 1:24000

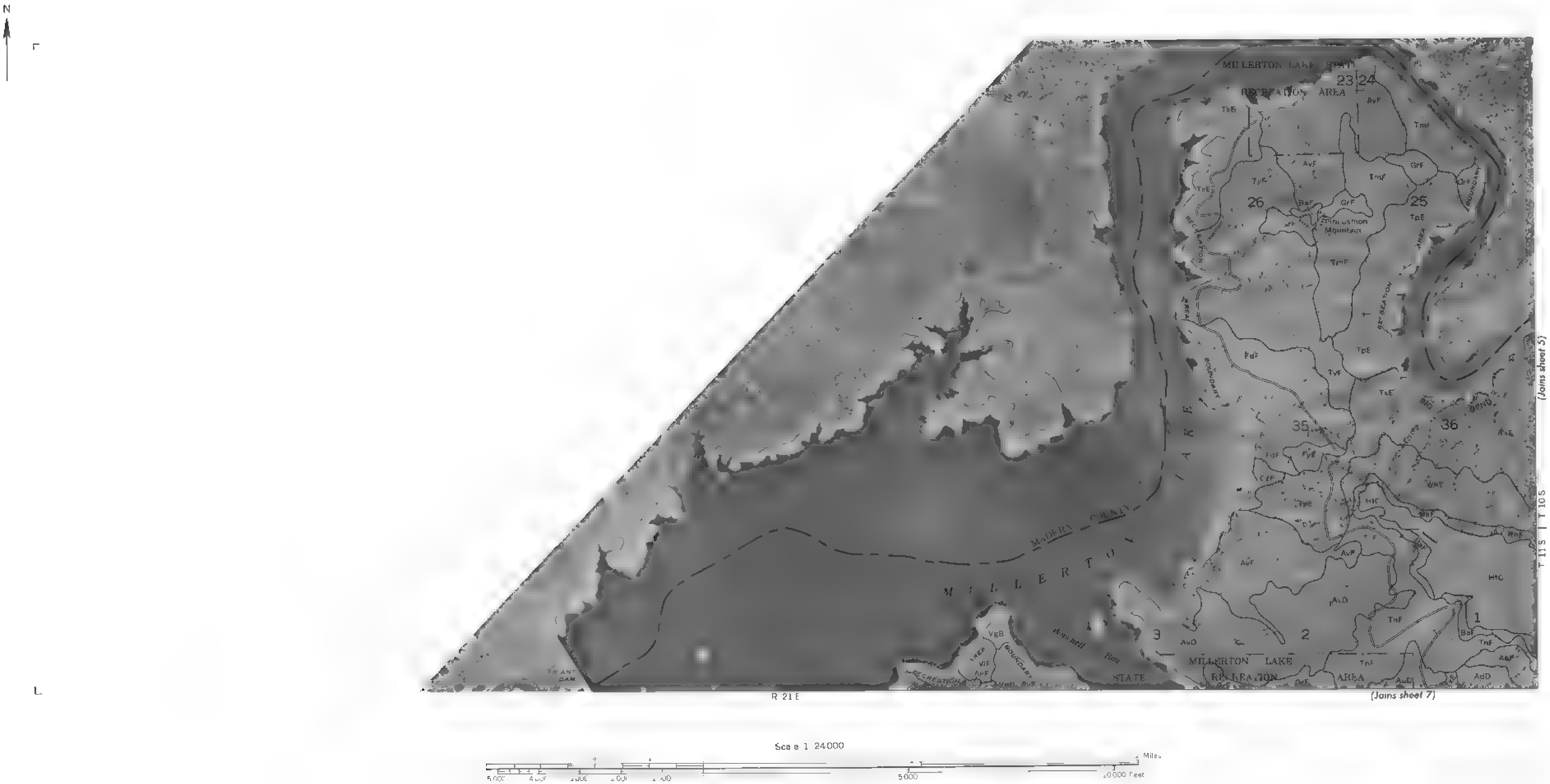
2 Miles

10,000 Feet

Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA NO. 3

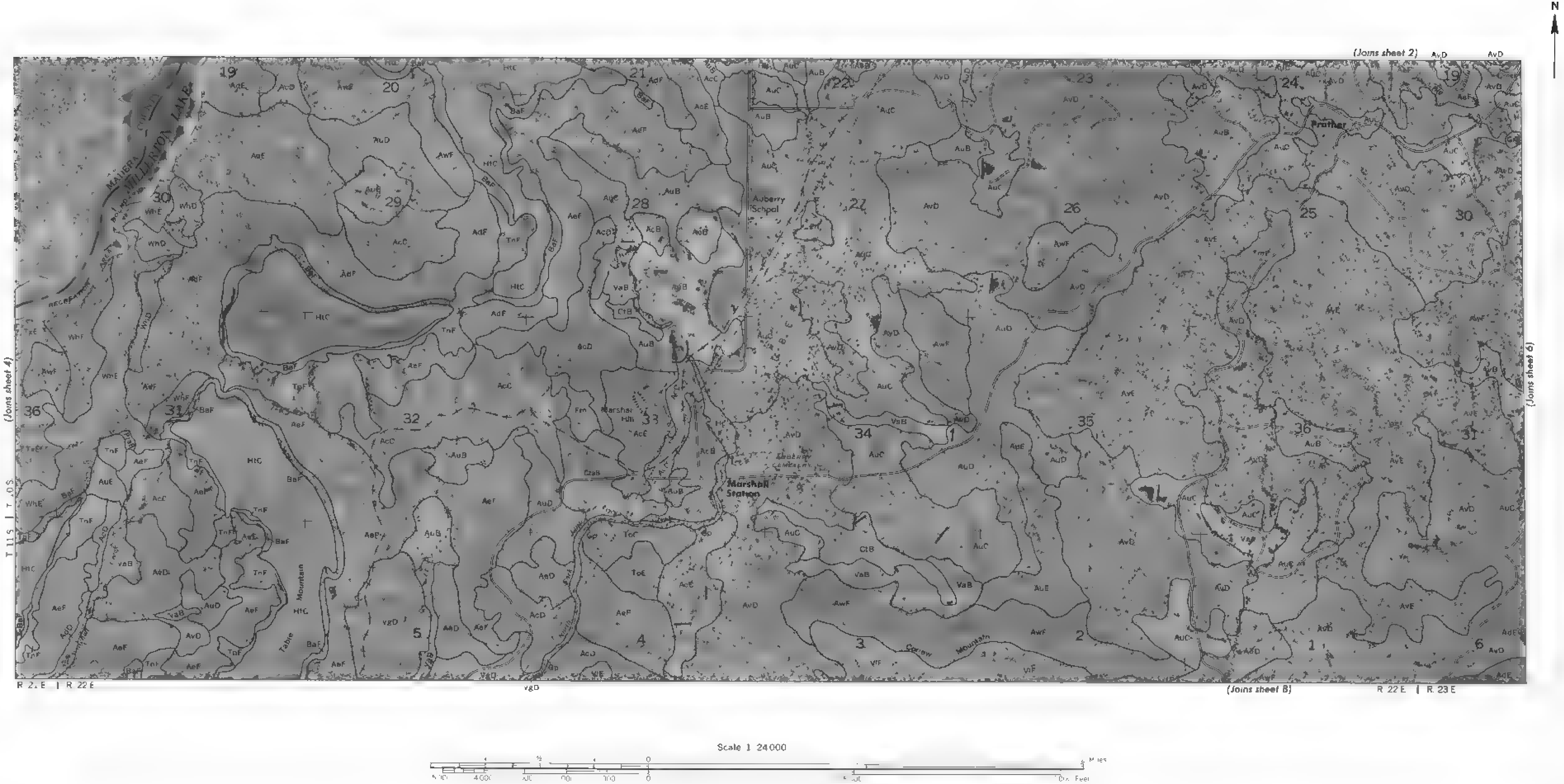
EASTERN FRESNO AREA CALIFORNIA — SHEET NUMBER 4



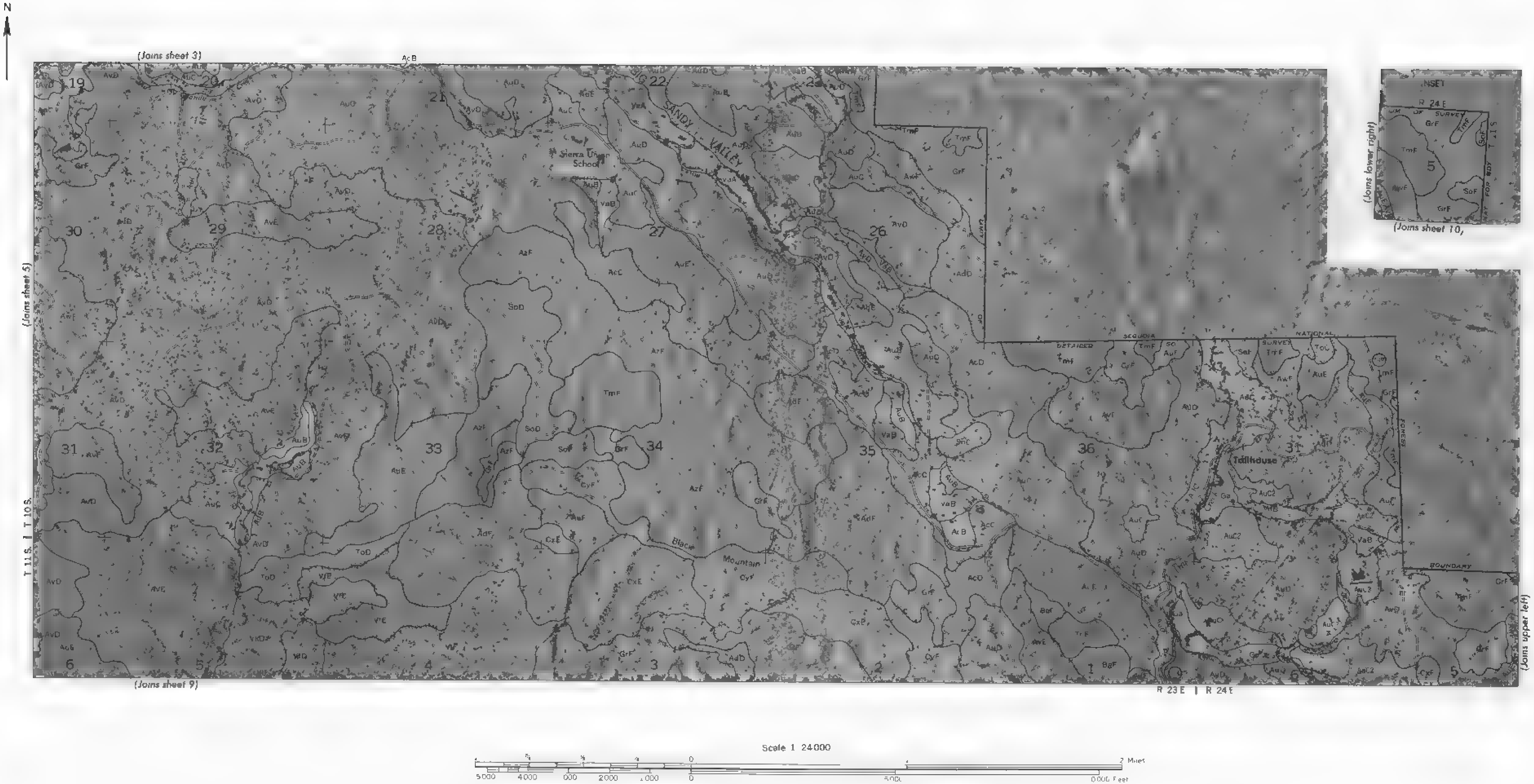
EASTERN FRESNO AREA, CALIFORNIA NO. 4

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.



This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.



EASTERN FRESNO AREA, CALIFORNIA NO. 6

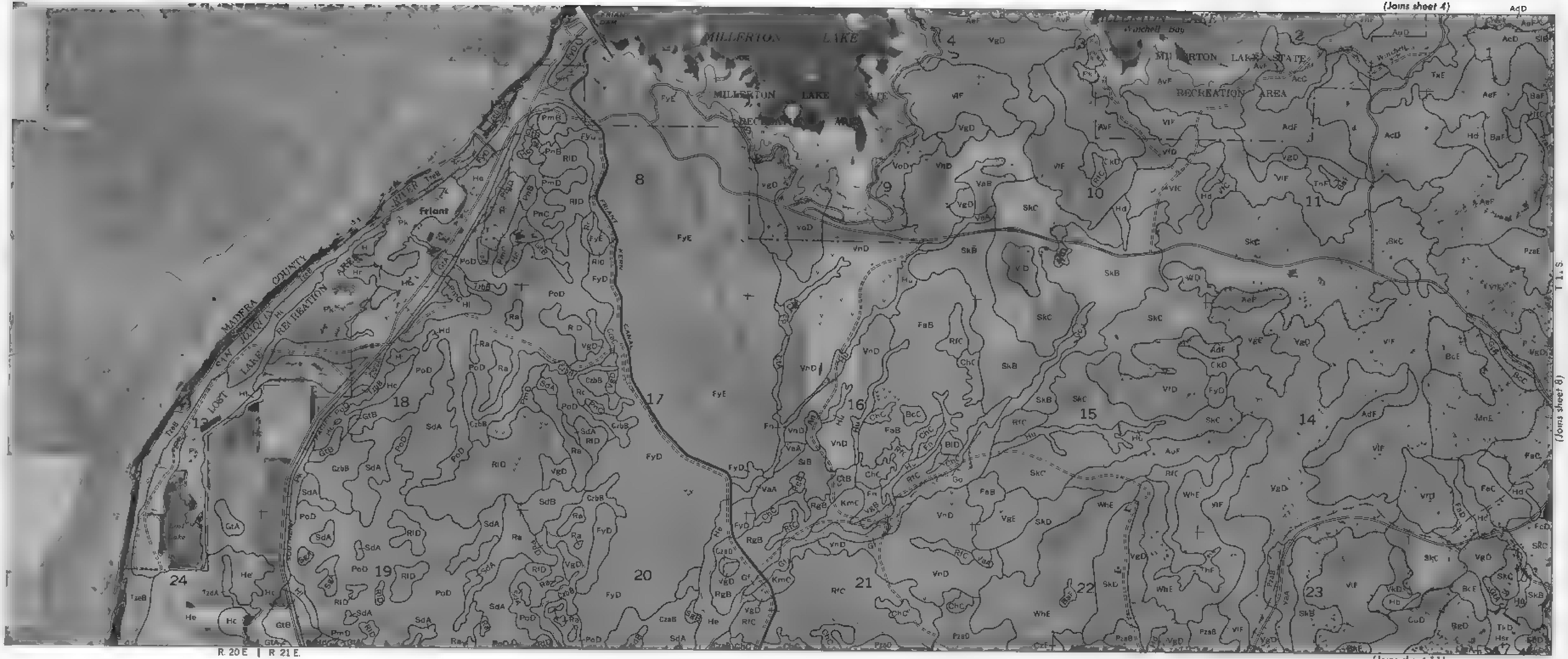
Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA NO. 7

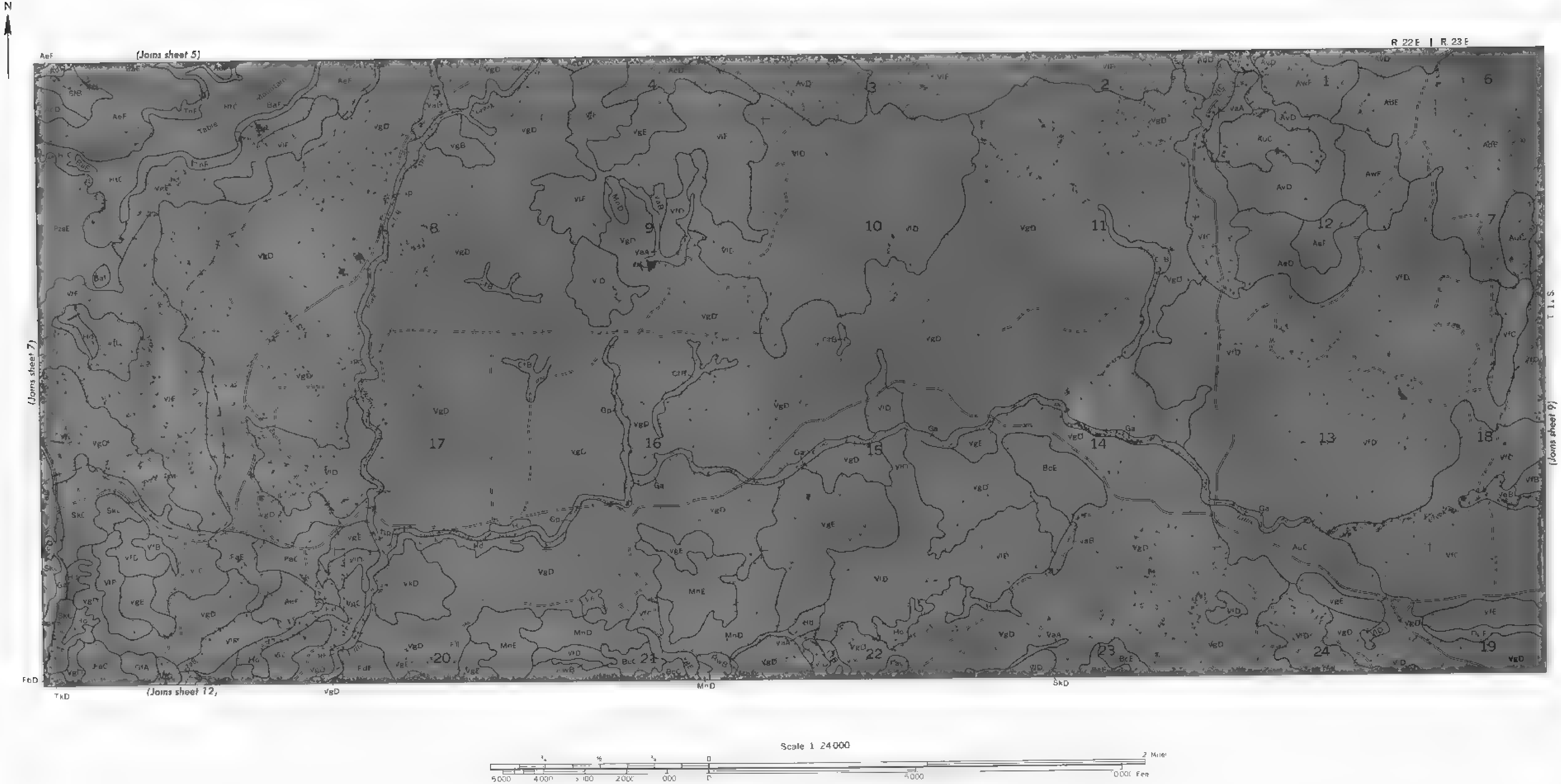
N



Scale 1:24000

½ ¼ ⅛ 0 2 Mile

5000 4000 3000 2000 1000 0 5000 10000 Feet



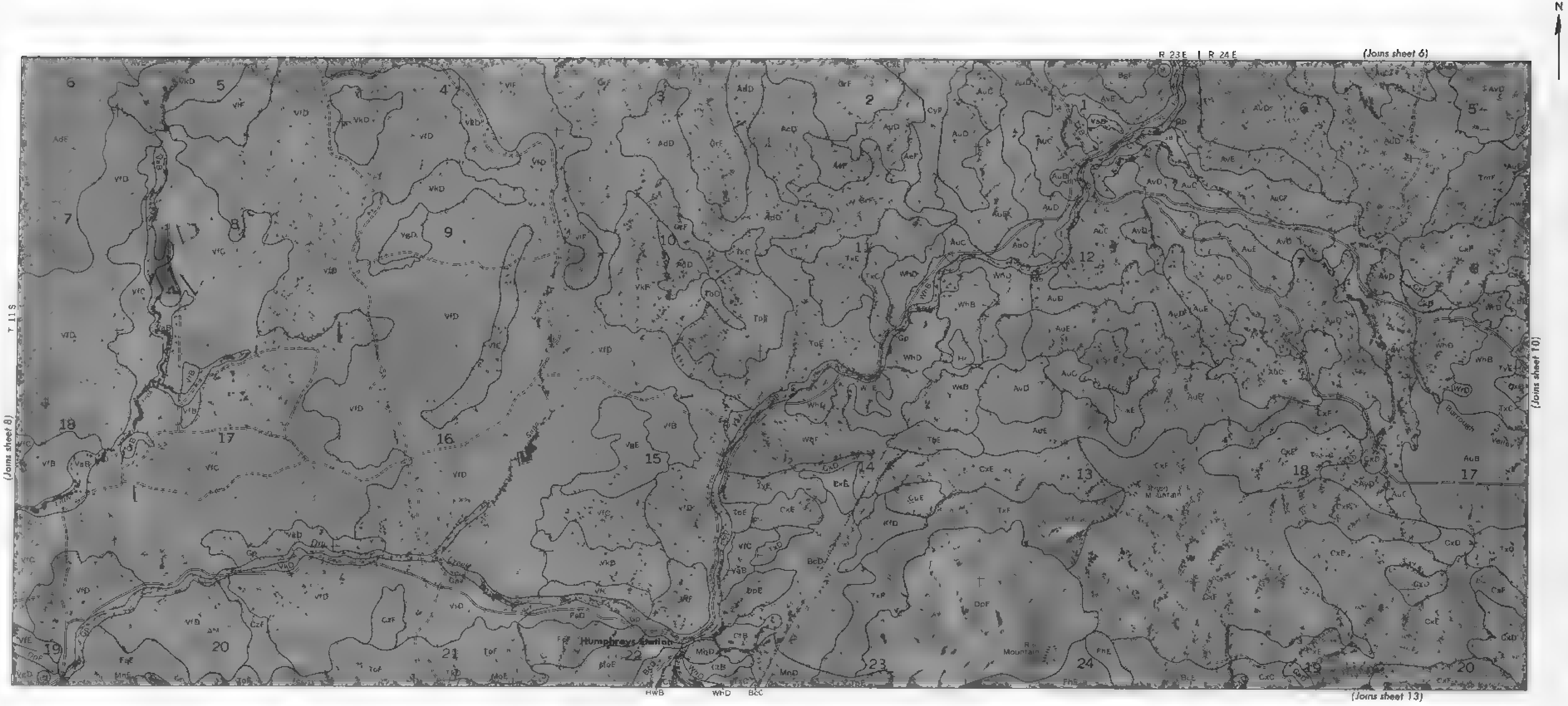
EASTERN FRESNO AREA, CALIFORNIA NO. 8

Land division corners are approximately positioned on this map

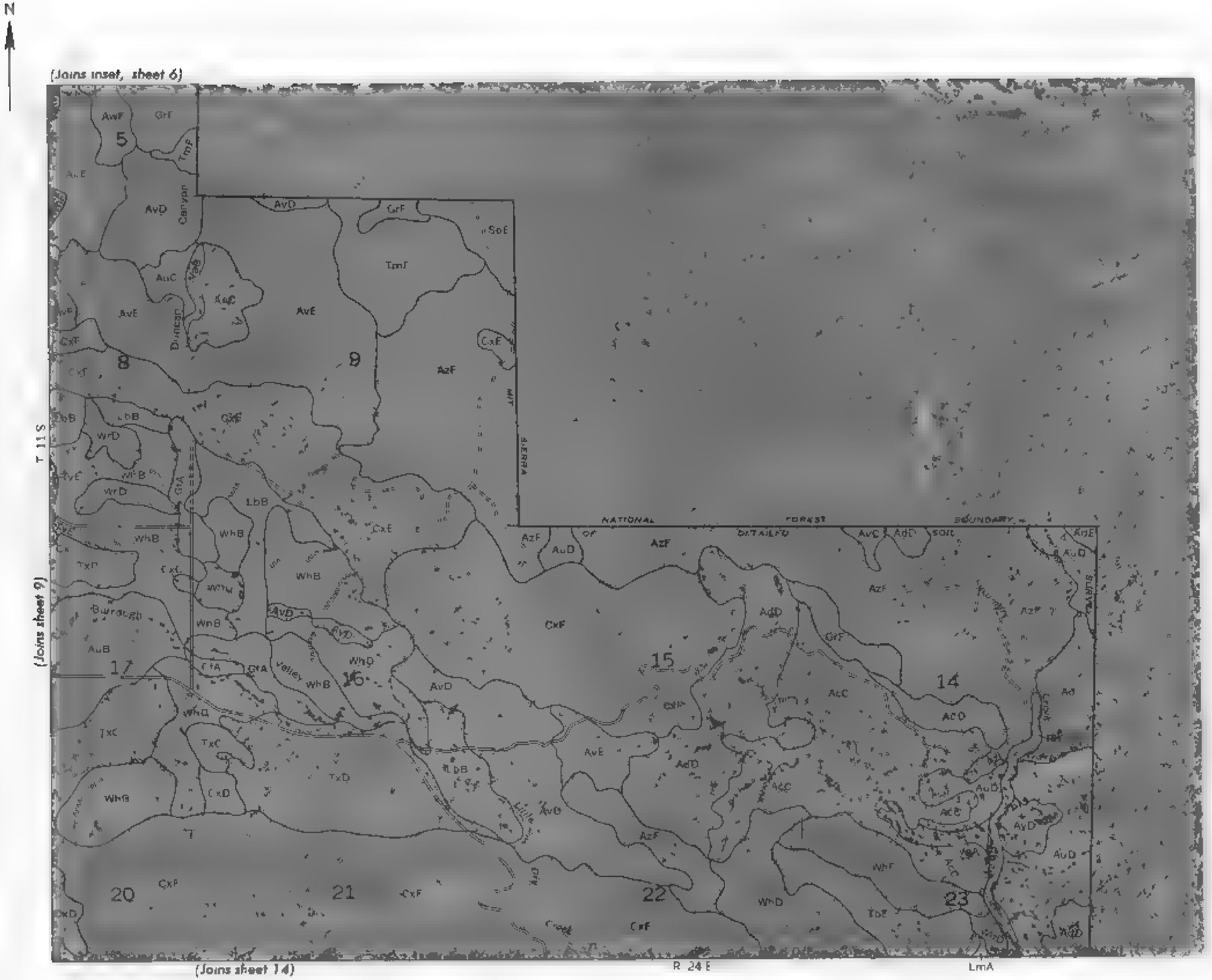
This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA NO. 9



Scale 1:24000



Scale 1:24000

2 Miles

10000 Feet

EASTERN FRESNO AREA, CALIFORNIA NO. 10

Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

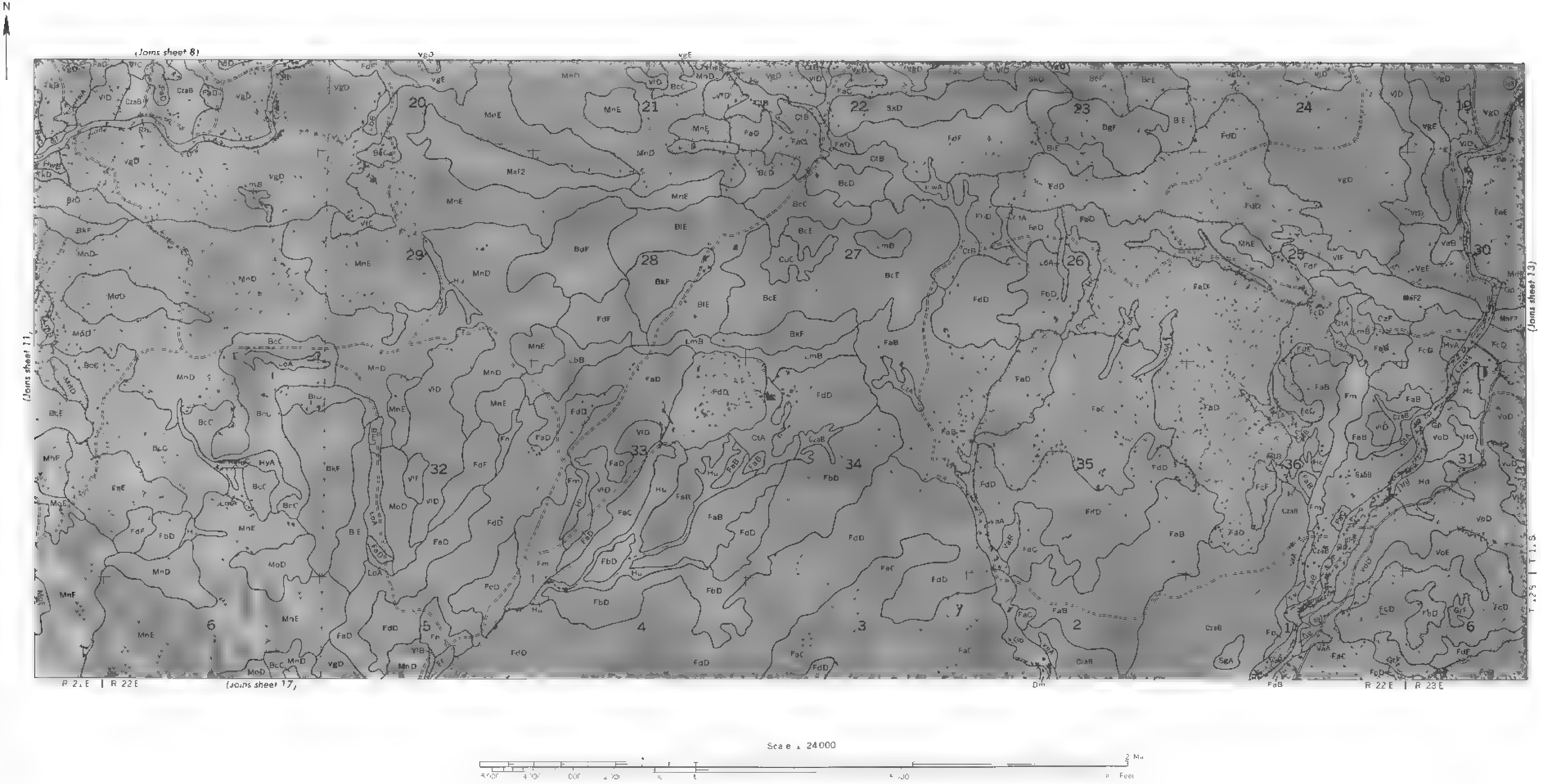
EASTERN FRESNO AREA, CALIFORNIA NO. 11

N

Scale 1:24000

1/2 1/4 0 2 Miles

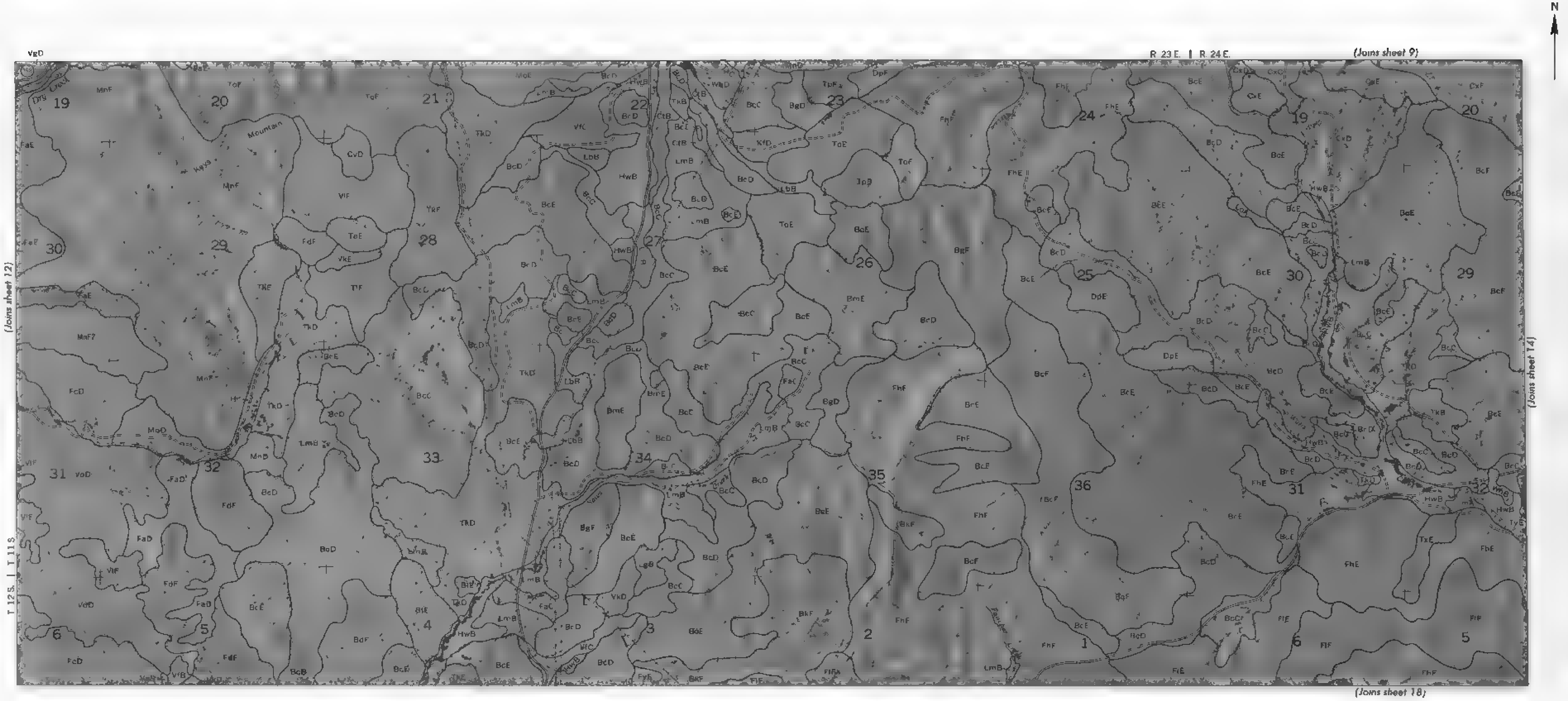
5000 4000 3000 2000 1000 0 5000 10000 Feet



Scale 1:24000

EASTERN FRESNO AREA, CALIFORNIA NO. 12
Land division corners are approximately positioned on this map
This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.
EASTERN FRESNO AREA, CALIFORNIA NO. 13

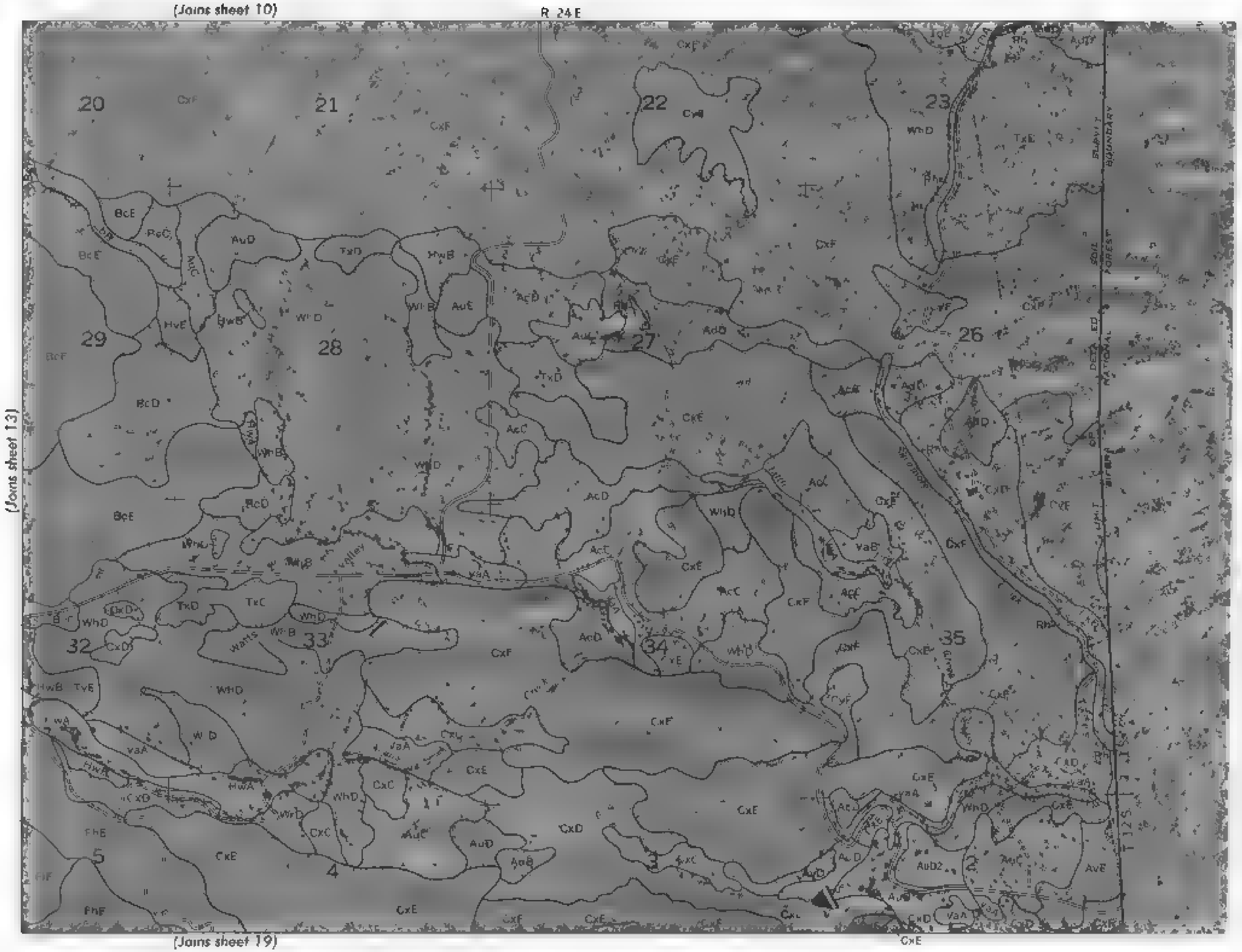


Scale 1:24 000

1 ¾ ½ ¼ 0 1 2 Miles

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet

N



Scale 1:24 000

1 ½ 0 1 Miles

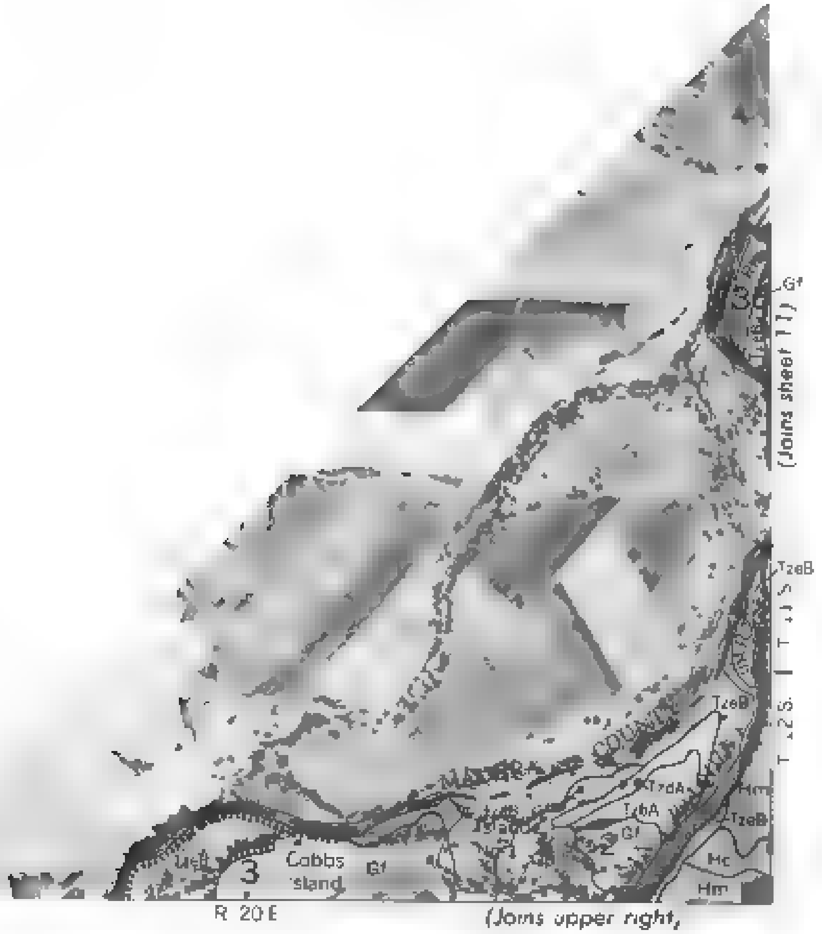
5000 4000 3000 2000 1000 0 5000 10000 Feet

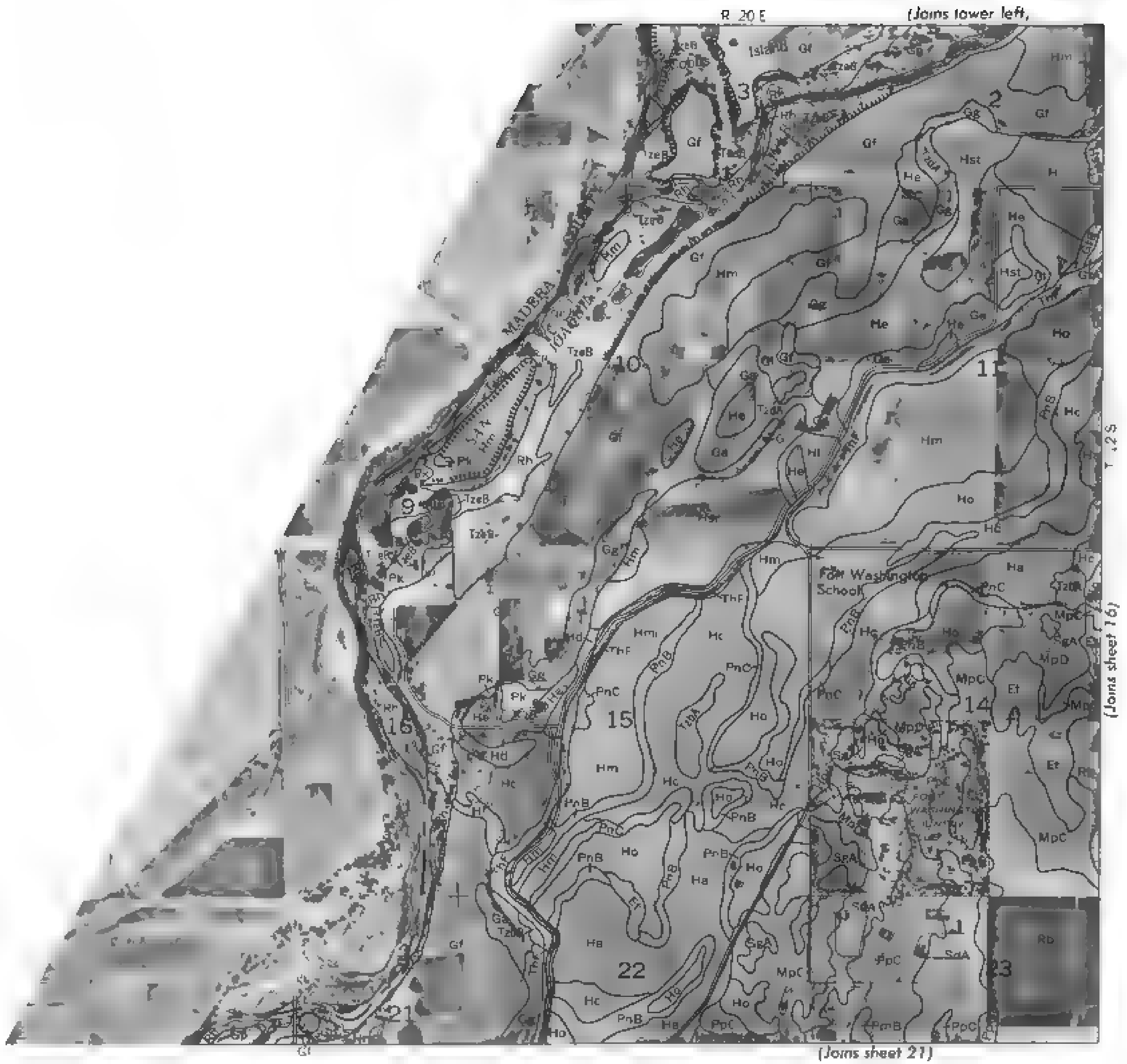
EASTERN FRESNO AREA, CALIFORNIA NO. 14

Land division corners are approximately positioned on this map

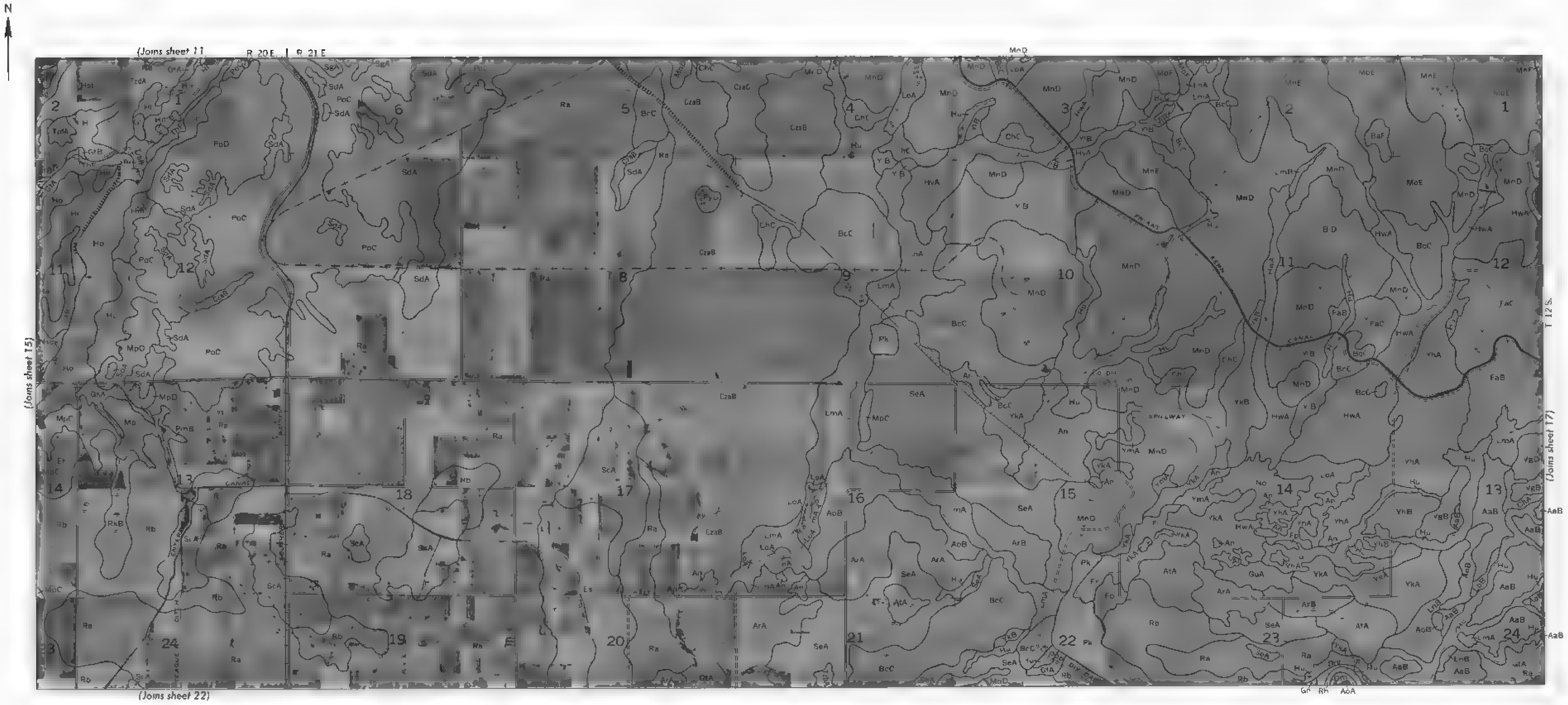
This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station

N





Scale 1:24 000



Scale 1:24000

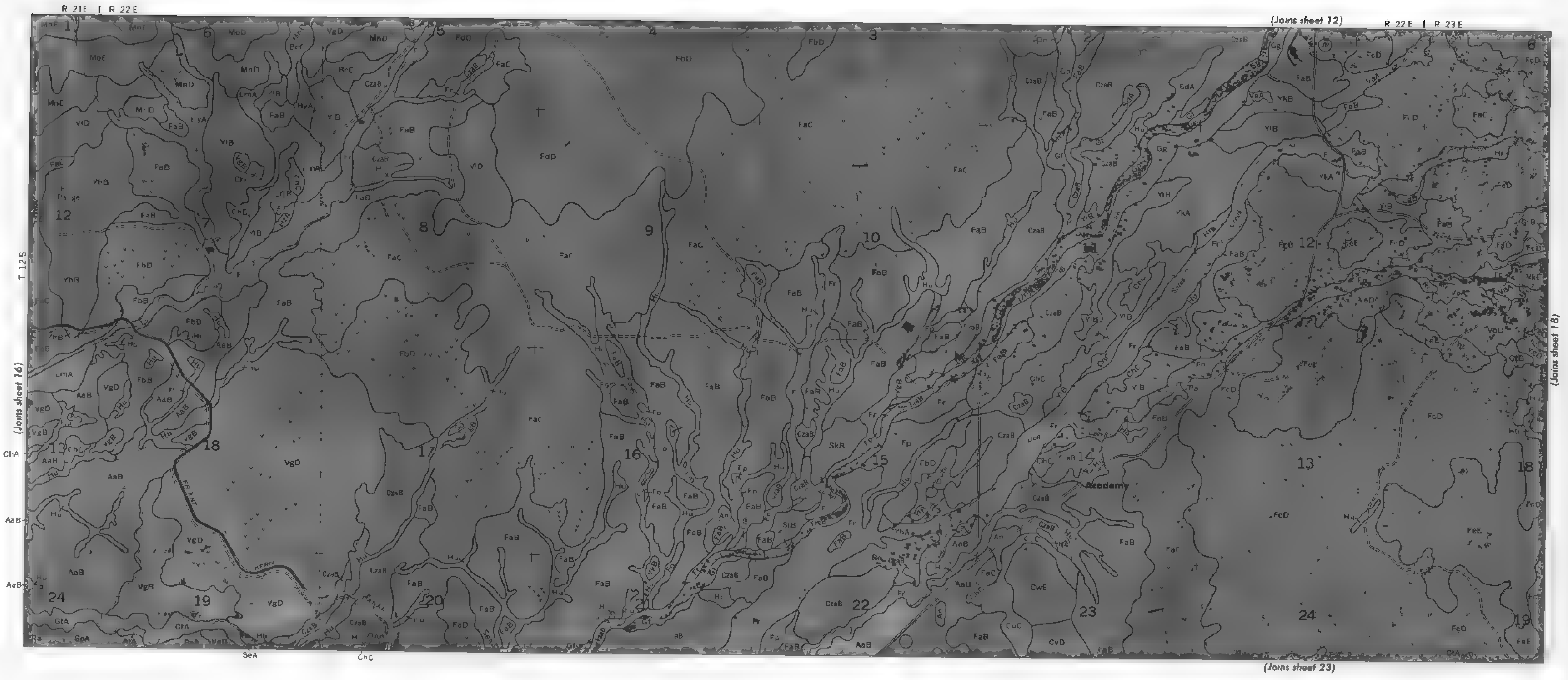
1/2 … 0 … 2 Miles

5000 4000 3000 2000 1000 0 … 5000 … 10000 Feet

EASTERN FRESNO AREA, CALIFORNIA NO. 16

Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station



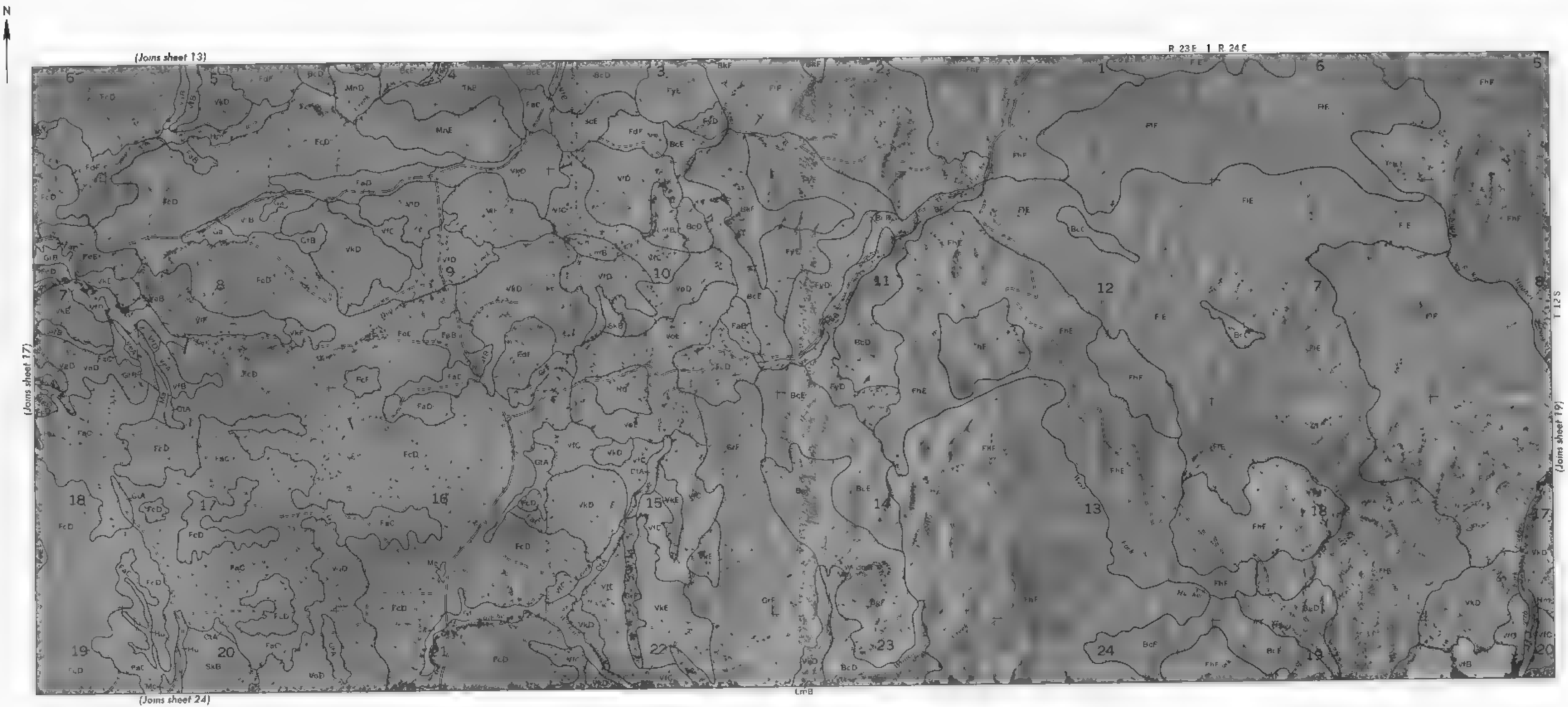
This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA NO. 7

Scale 1:24 000

Miles
5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet

EASTERN FRESNO AREA CALIFORNIA — SHEET NUMBER 18



Scale 1:24000

2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

EASTERN FRESNO AREA, CALIFORNIA NO. 18

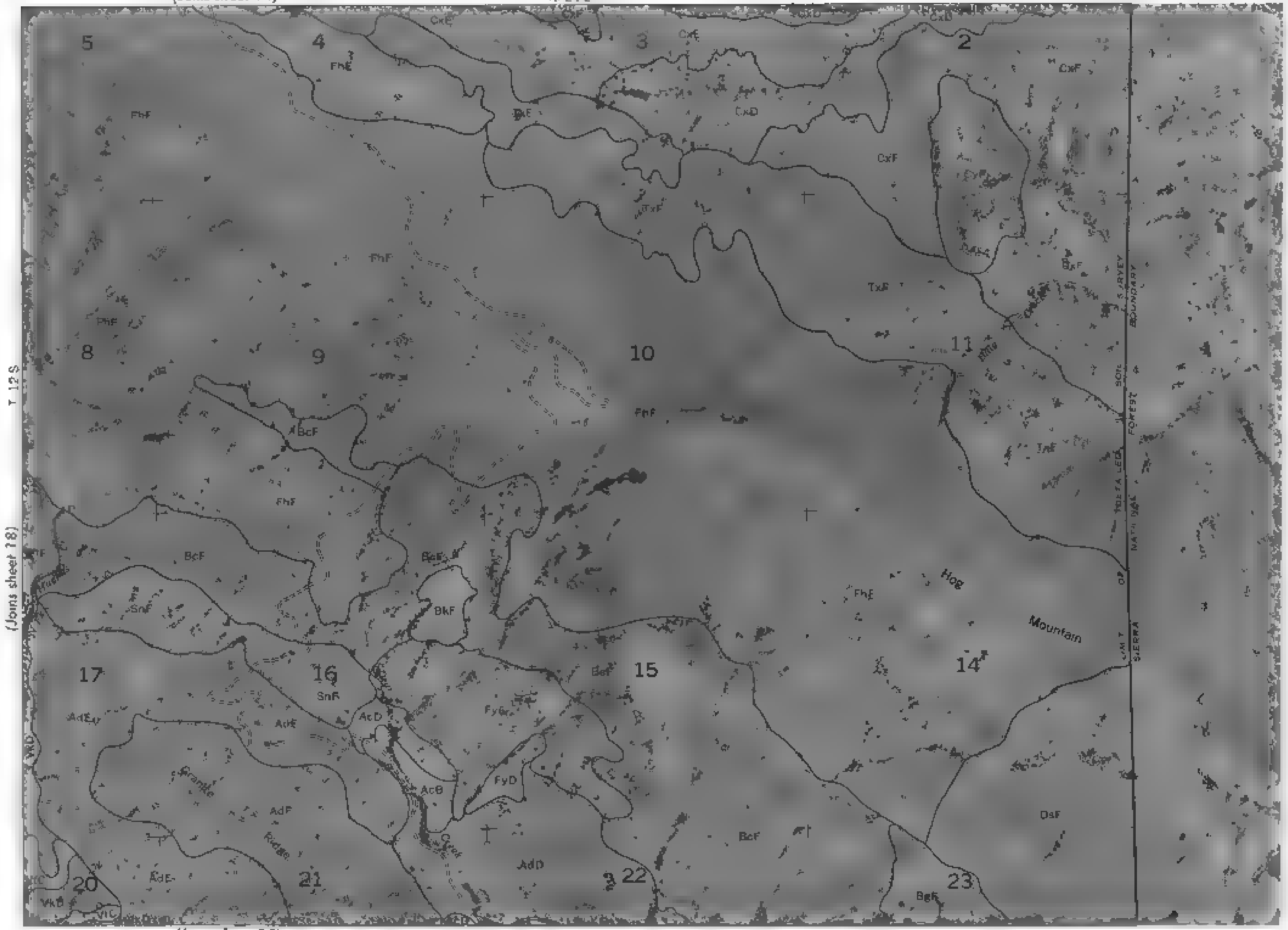
Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station

19

N

(Joins sheet 14)



(Joins sheet 25)

Scale 1:24 000

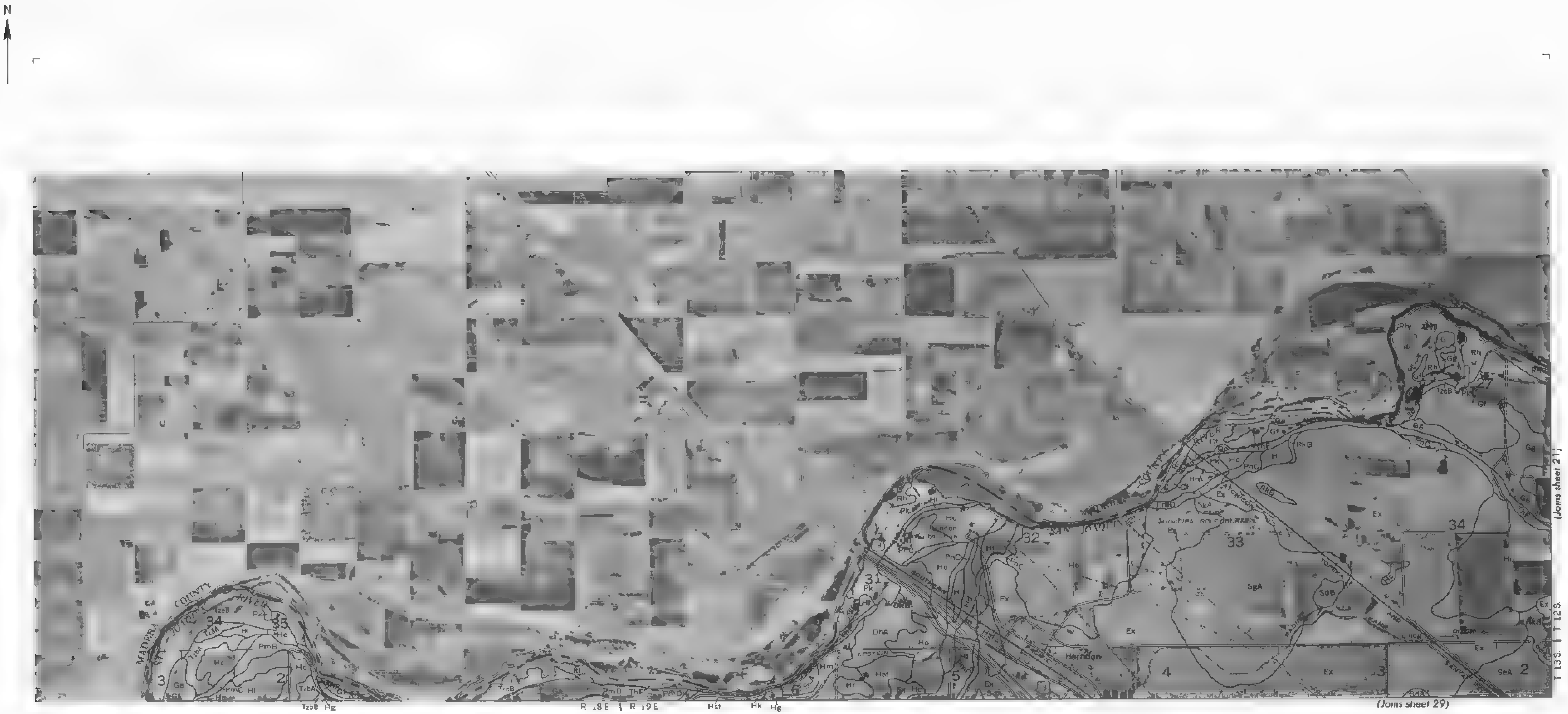
1 ¾ ½ ¼ 0 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA NO. 19



Scale 1:24 000

2 Miles

5000 4000 3000 2000 1000 0 5000 10 000 Feet

EASTERN FRESNO AREA, CALIFORNIA NO. 20

Land division corners are approximately positioned on this map

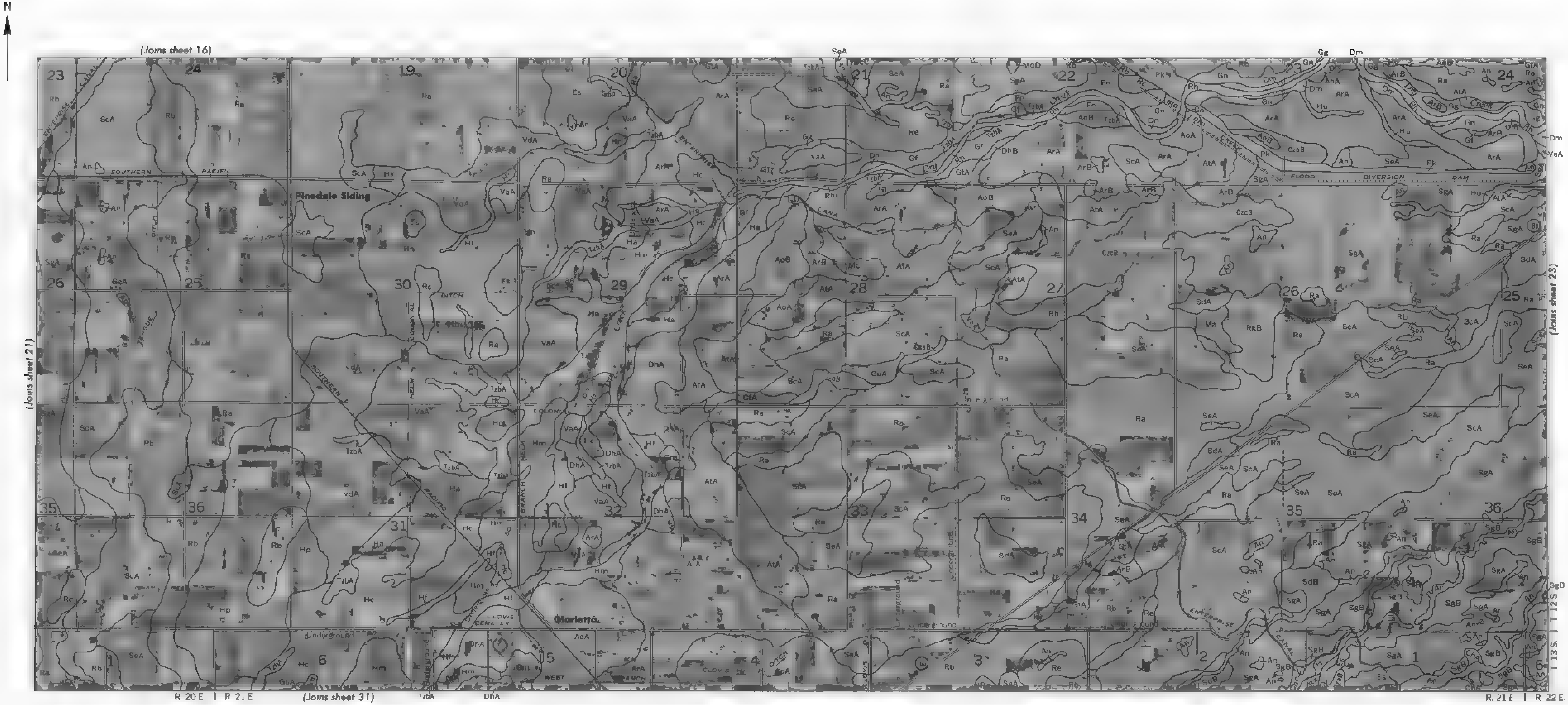
This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station

Scale 1:24000

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA NO. 2

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 22



Scale 1:24 000

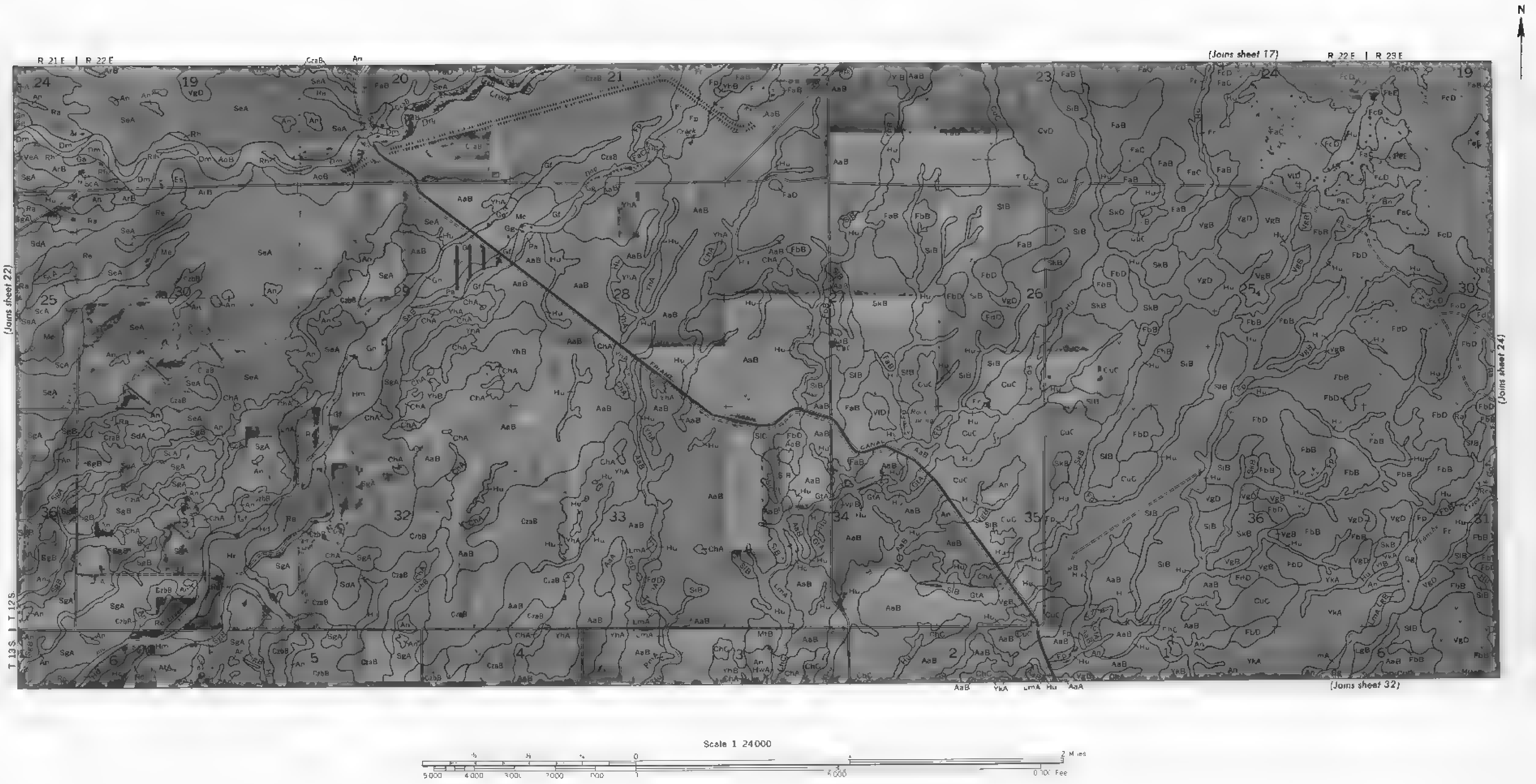
1 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

EASTERN FRESNO AREA, CALIFORNIA NO. 22

Land division corners are approximately positioned on this map

This map is one of a set compiled in 1958 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station

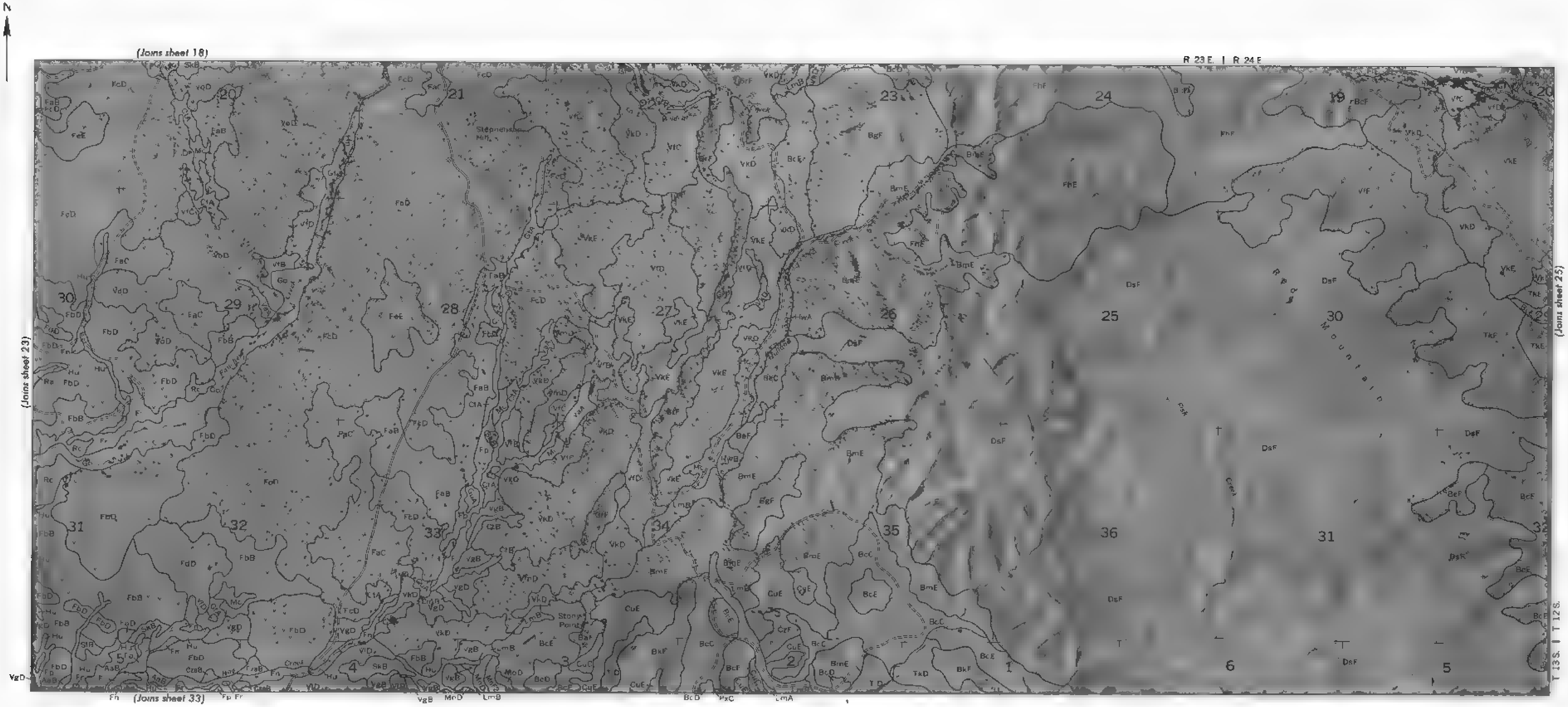


This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA NO. 23

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 24



Scale 1:24 000

EASTERN FRESNO AREA, CALIFORNIA NO. 24

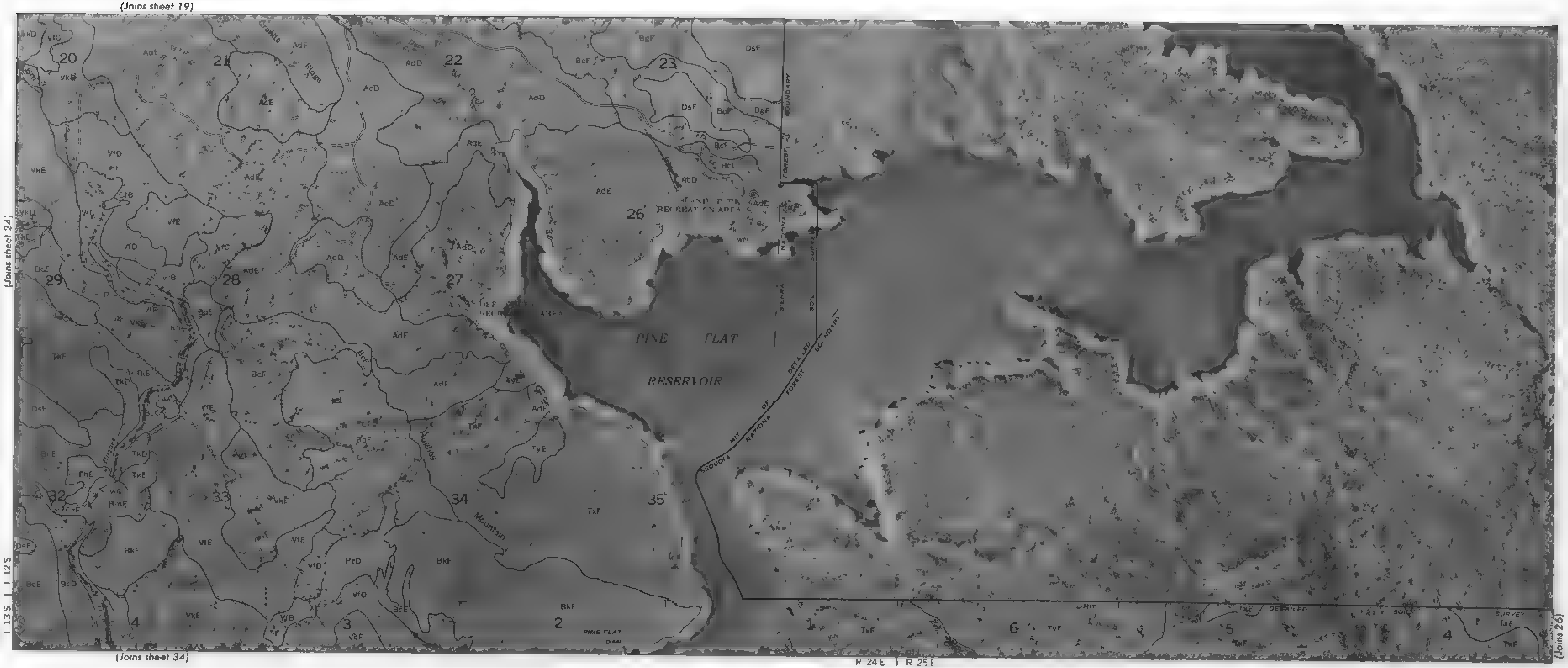
Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

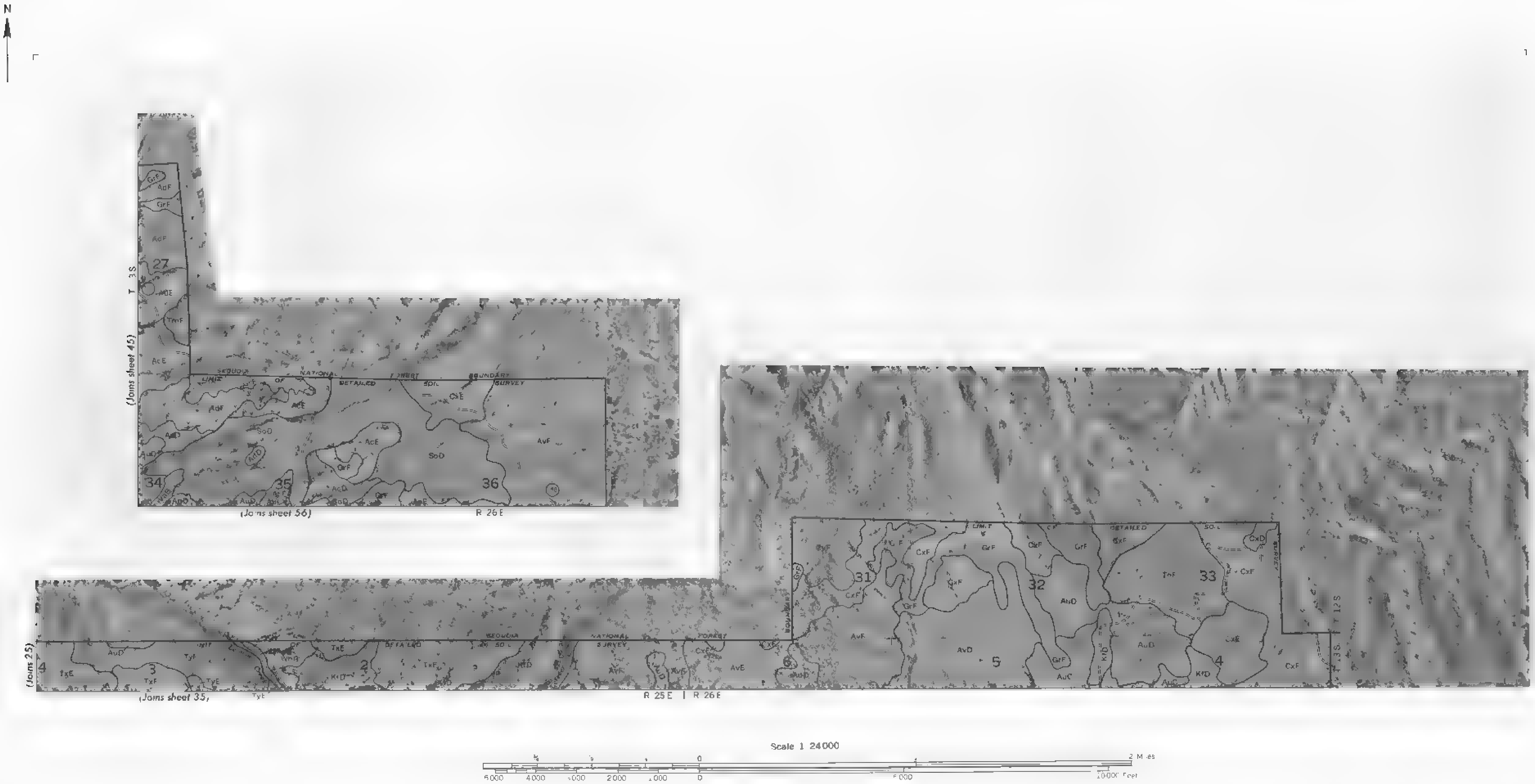
EASTERN FRESNO AREA, CALIFORNIA NO. 25

(Joins sheet 19)



Scale 1:24000

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 26



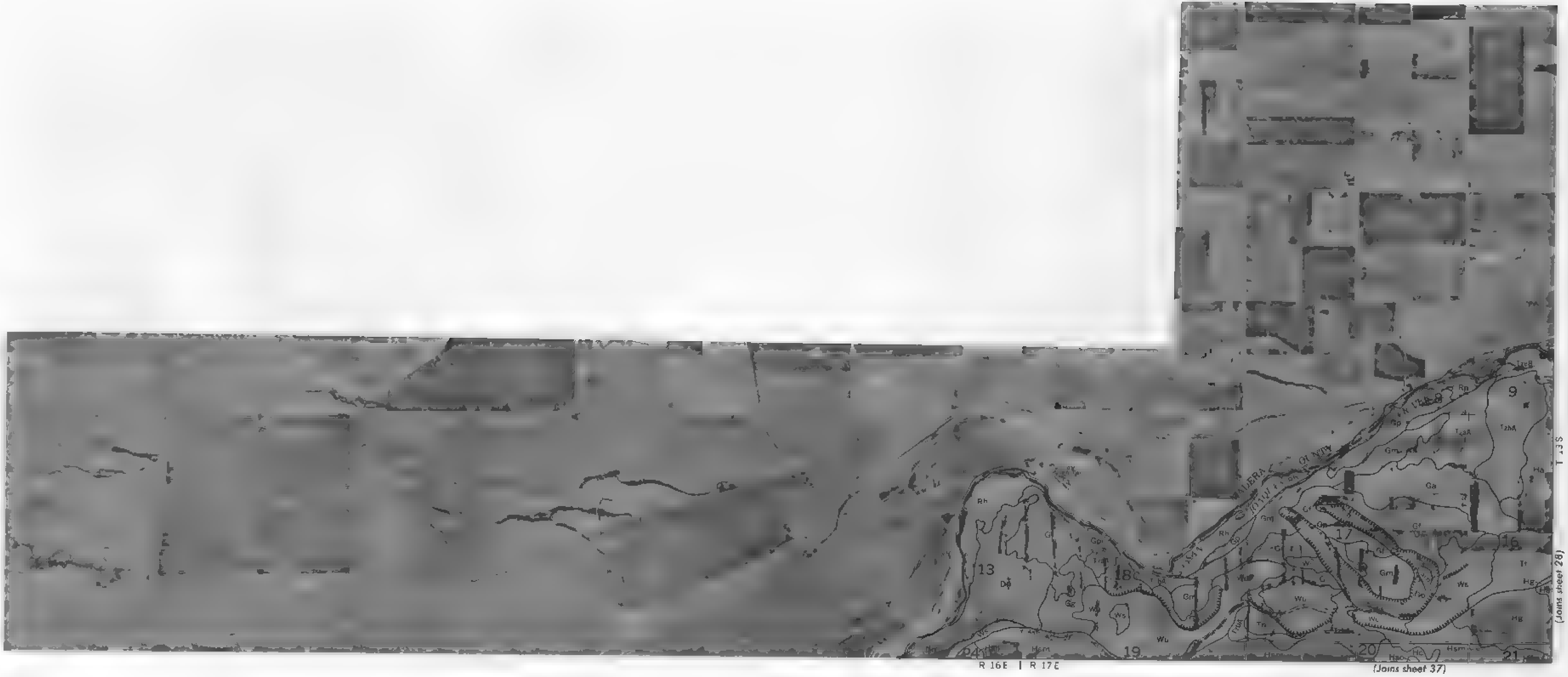
EASTERN FRESNO AREA, CALIFORNIA NO. 26

Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

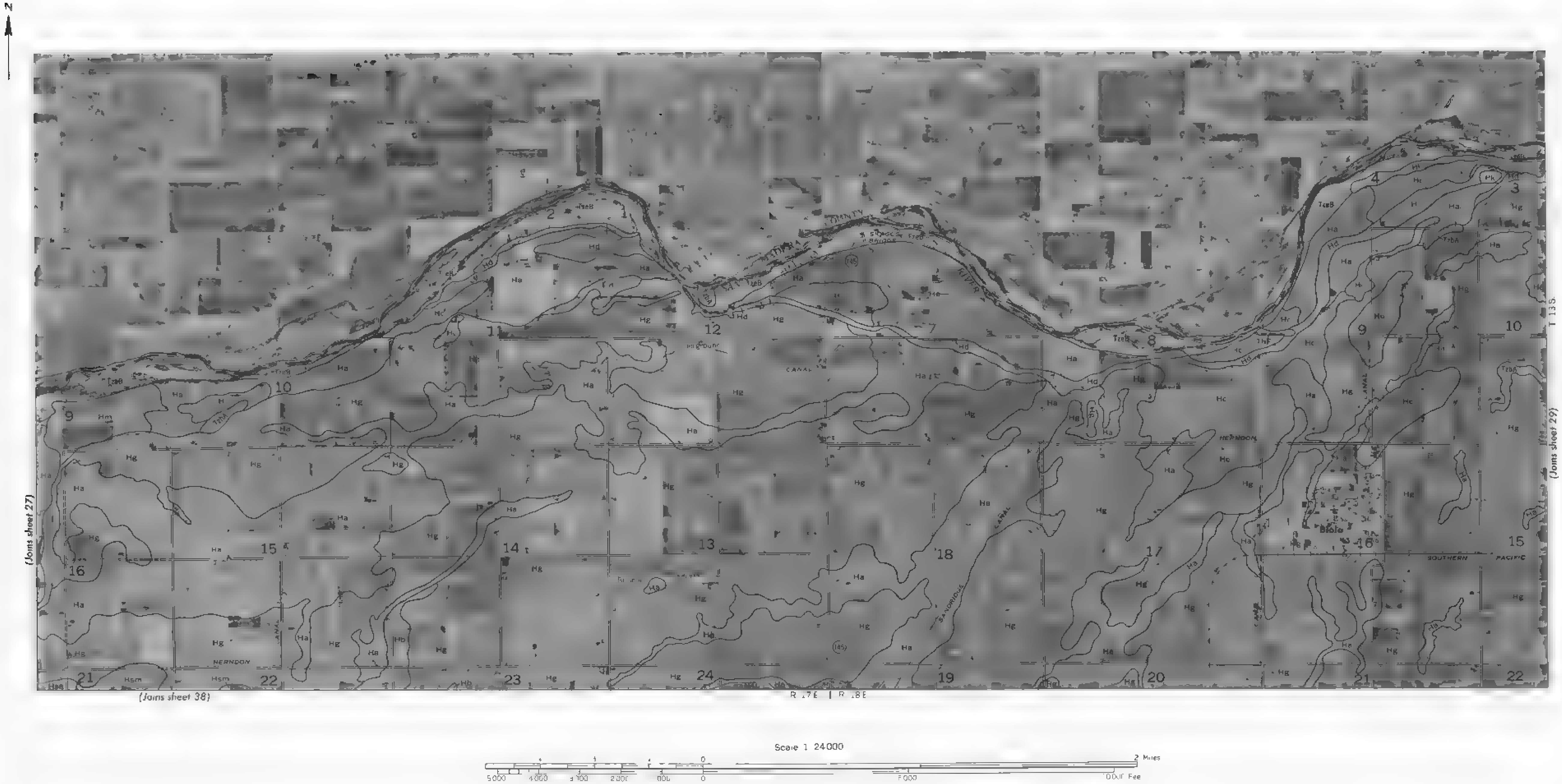
EASTERN FRESNO AREA, CALIFORNIA NO. 27



Scale 1:24 000

1 — 0 — 2 Miles

5 000 — 4 000 — 3 000 — 2 000 — 1 000 — 0 — 5 000 — 10 000 Feet



EASTERN FRESNO AREA, CALIFORNIA NO. 28

Land division corners are approximately positioned on this map

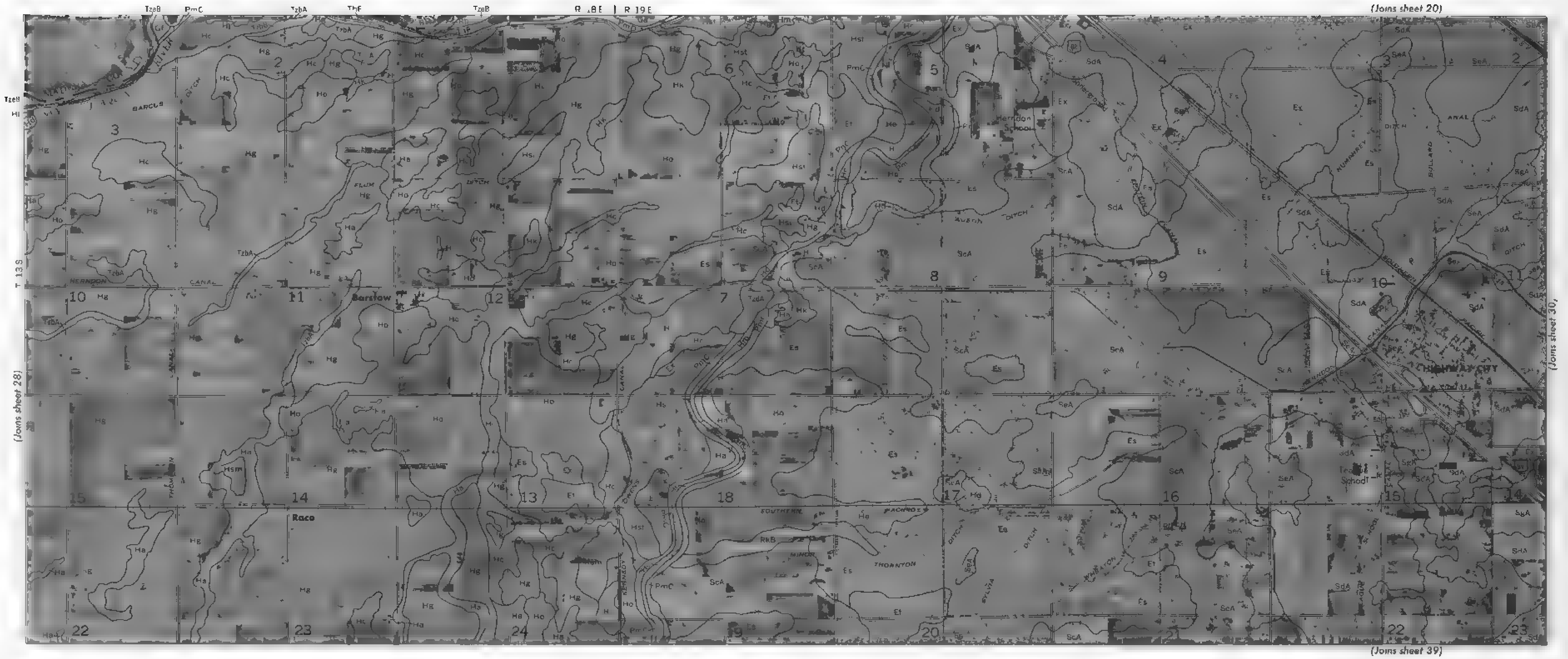
This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station

(29)

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station

Land division corners are approximately positioned on this map

EASTERN FRESNO AREA, CA. FORM NO. 29



Scale 1:24 000

1 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 30

Scale 1:24 000

EASTERN FRESNO AREA, CALIFORNIA NO. 30

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA NO. 3

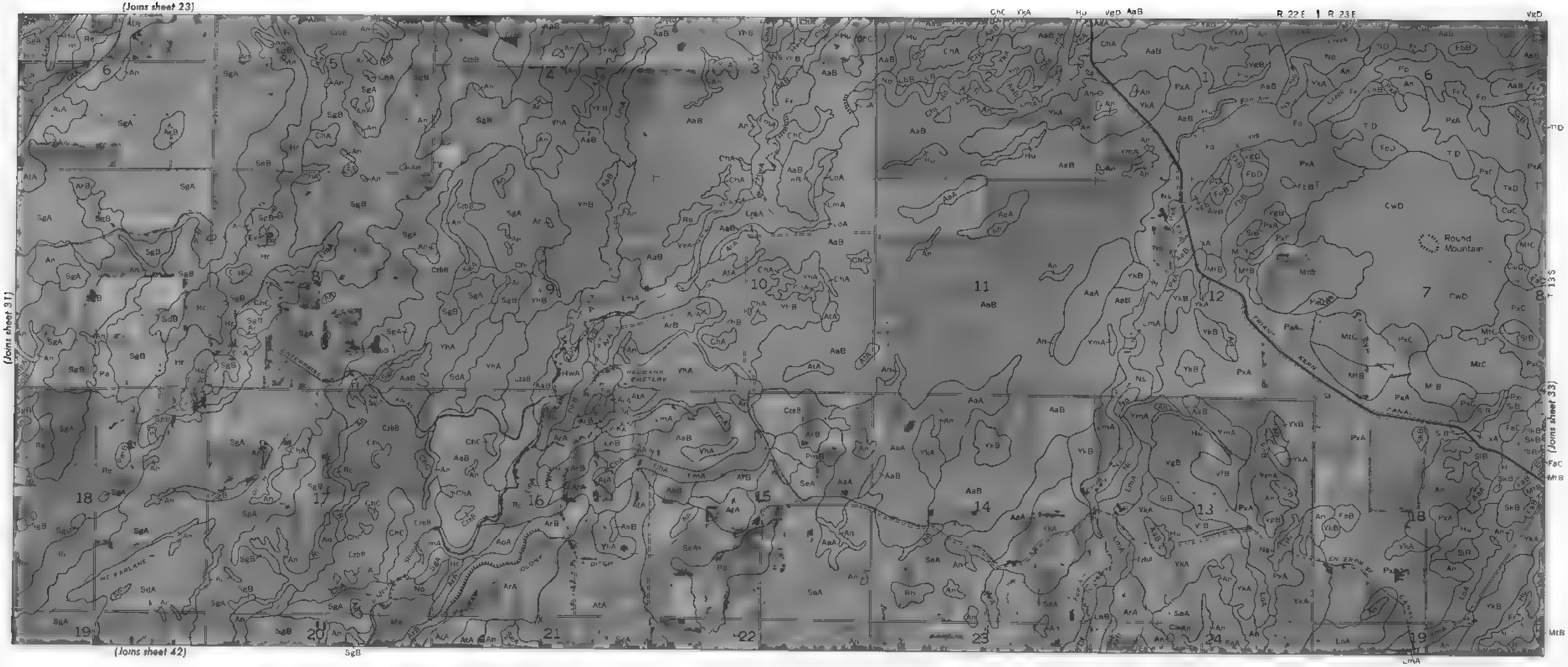
Scale 1:24000

2 Miles

5000 Feet

EASTERN FRESNO AREA CALIFORNIA — SHEET NUMBER 32

N



Scale 1:24000

1 | 1/2 | 0 | 2 Miles
5000 | 4000 | 3000 | 2000 | 1000 | 0 | 5000 | 10000 Feet

EASTERN FRESNO AREA, CALIFORNIA NO. 32

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

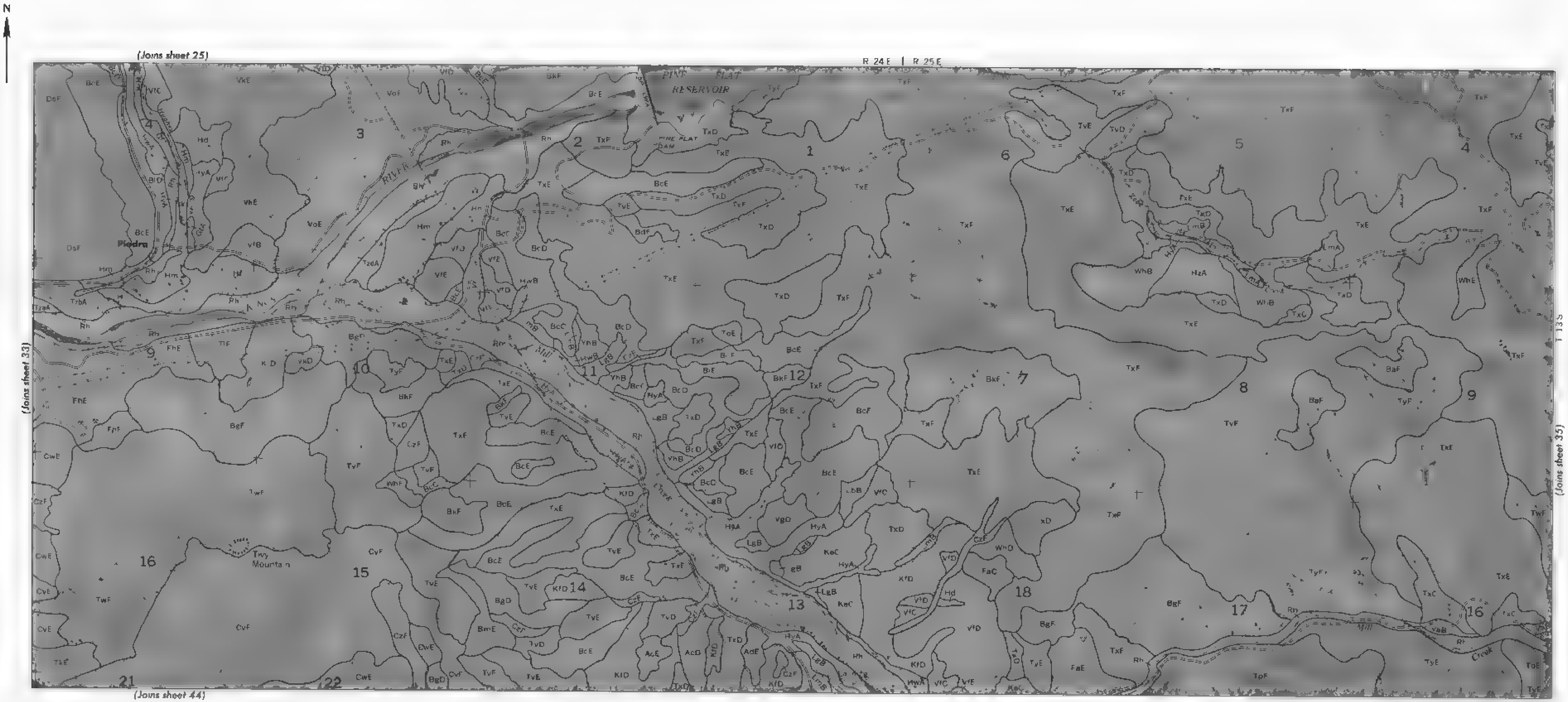
EASTERN FRESNO AREA, CALIFORNIA NO. 33

Scale 1:24000

2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 34



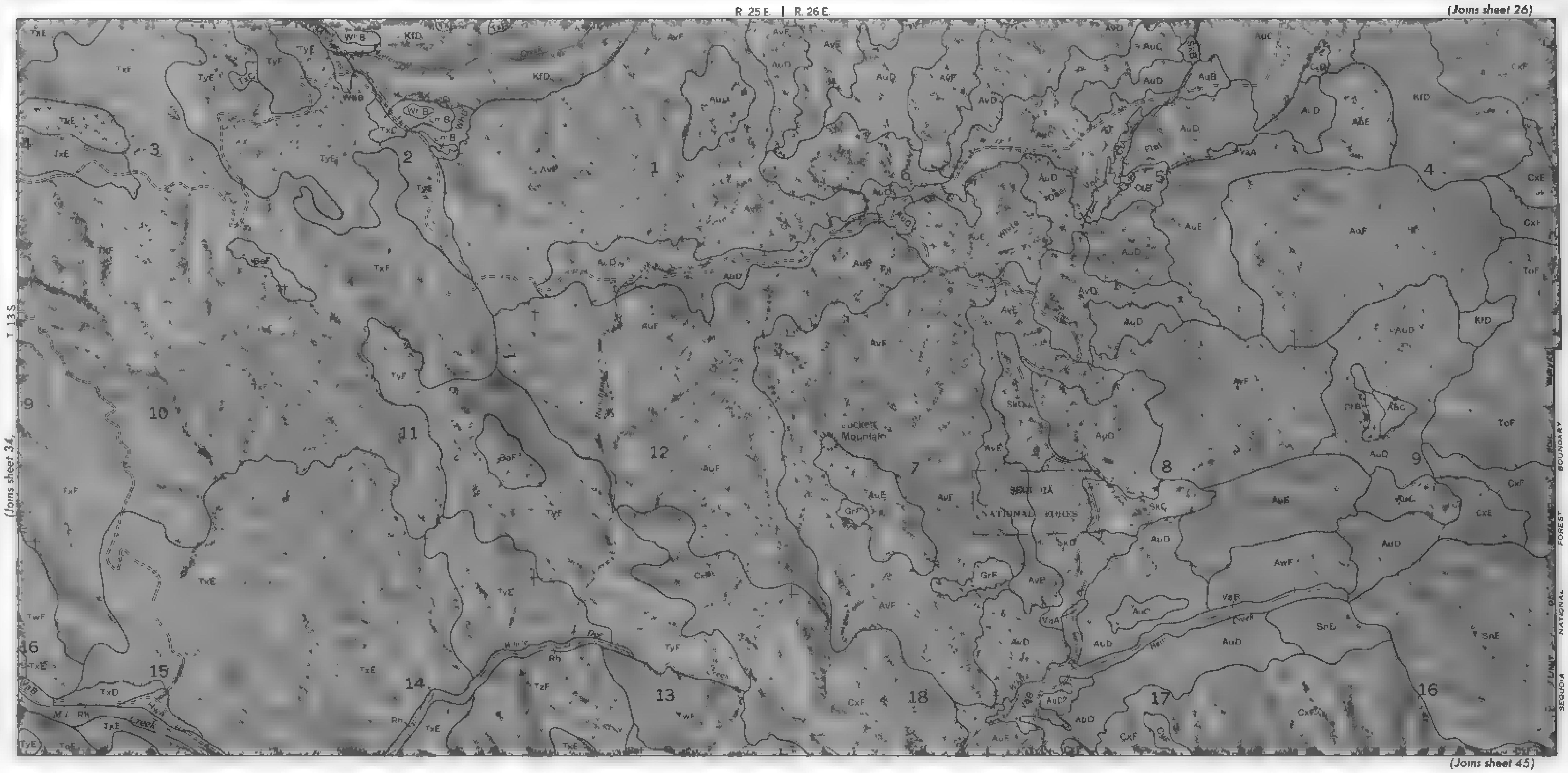
Scale 1:24 000

EASTERN FRESNO AREA, CALIFORNIA NO. 34

Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.

N

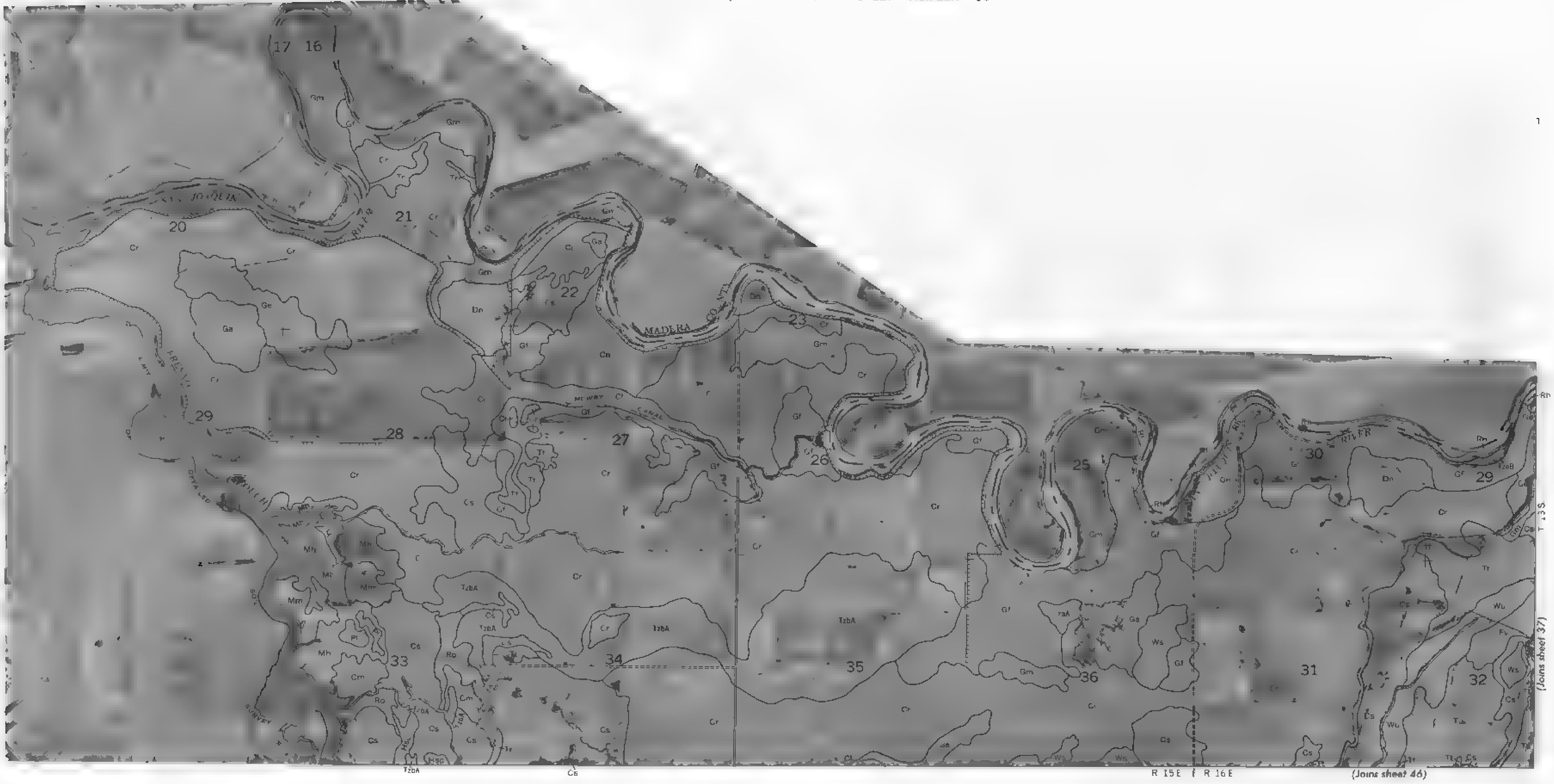


Scale 1:24000

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA NO. 35

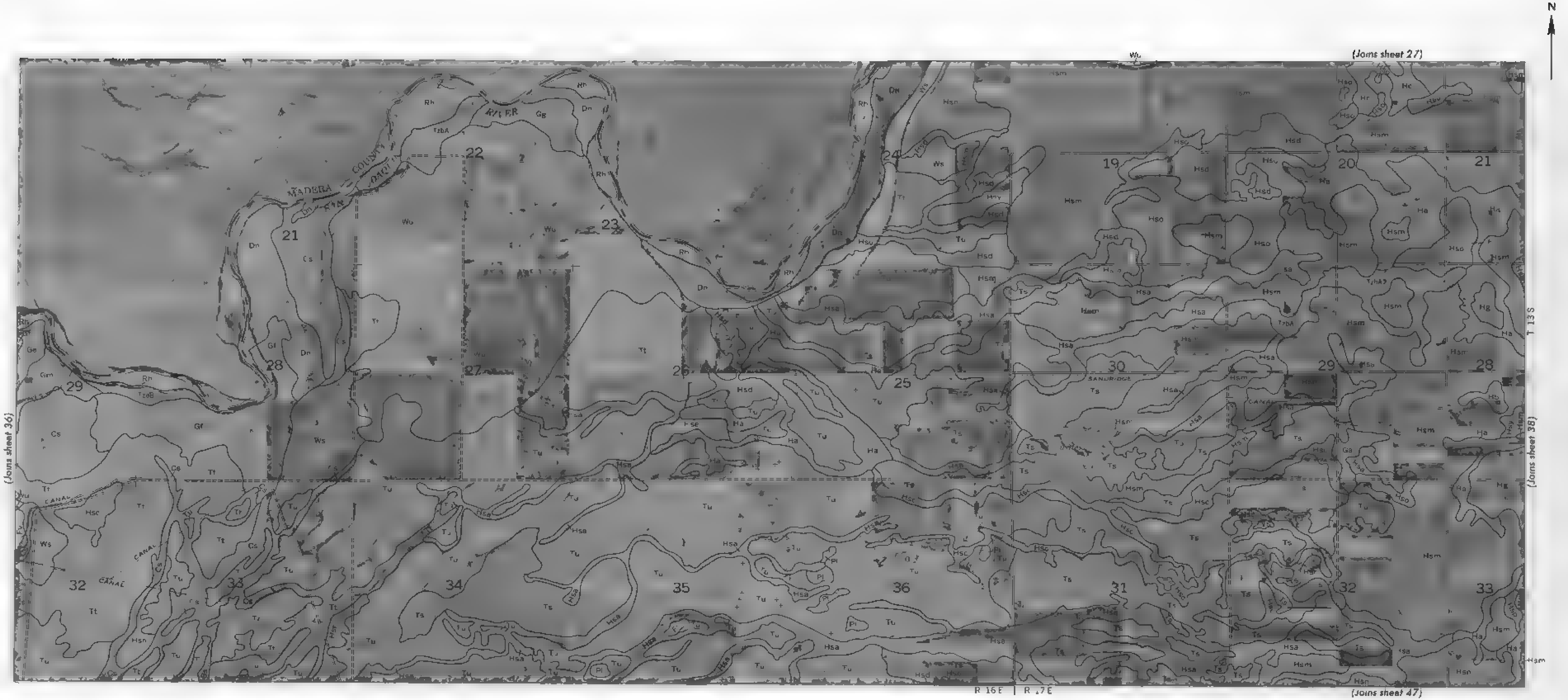
EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 36



Scale 1:24 000

EASTERN FRESNO AREA, CALIFORNIA NO. 36

Land division corners are approximately positioned on this map



Scale 1:24 000

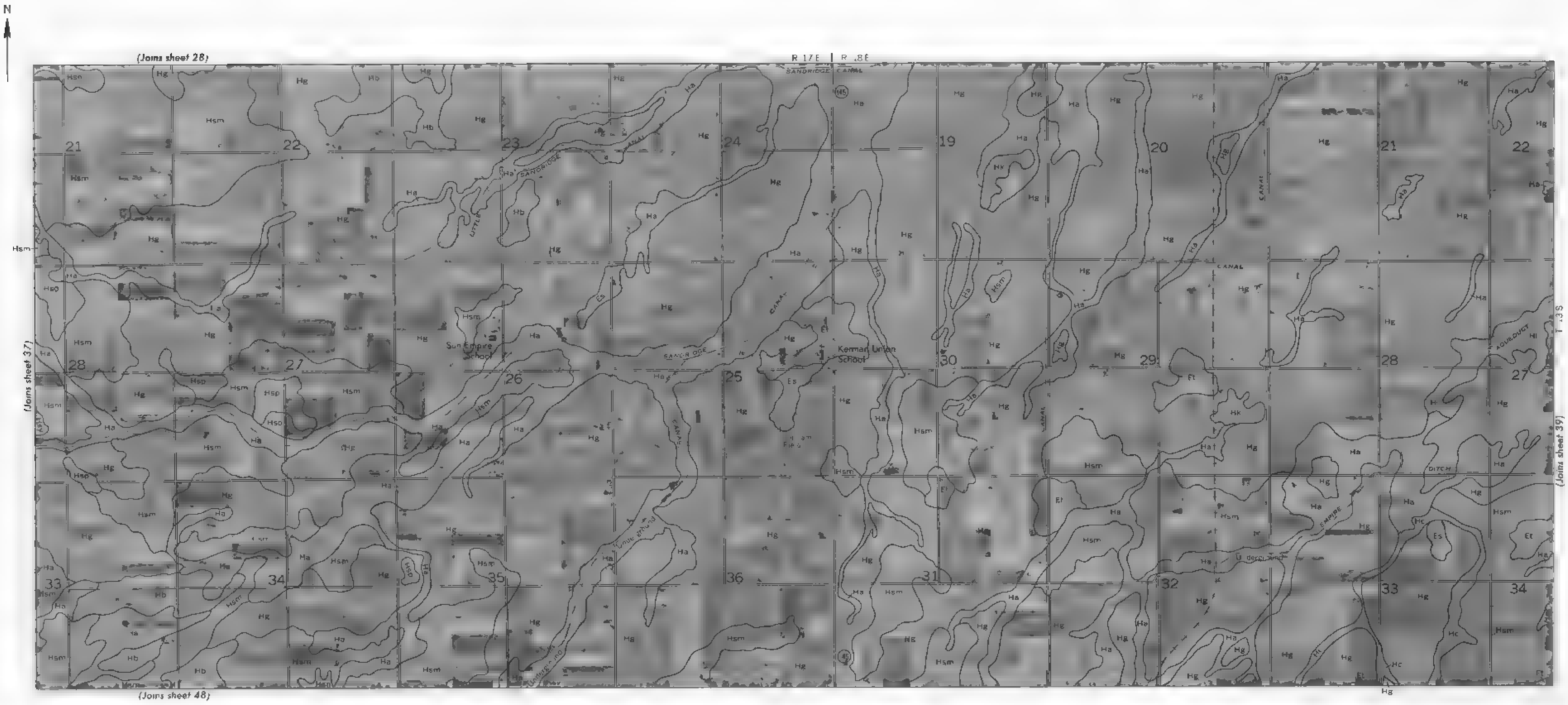
0 — 2 Miles

5000 — 4000 — 3000 — 2000 — 1000 — 0 — 5000 — 10000 Feet

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 38



Scale 1:24000

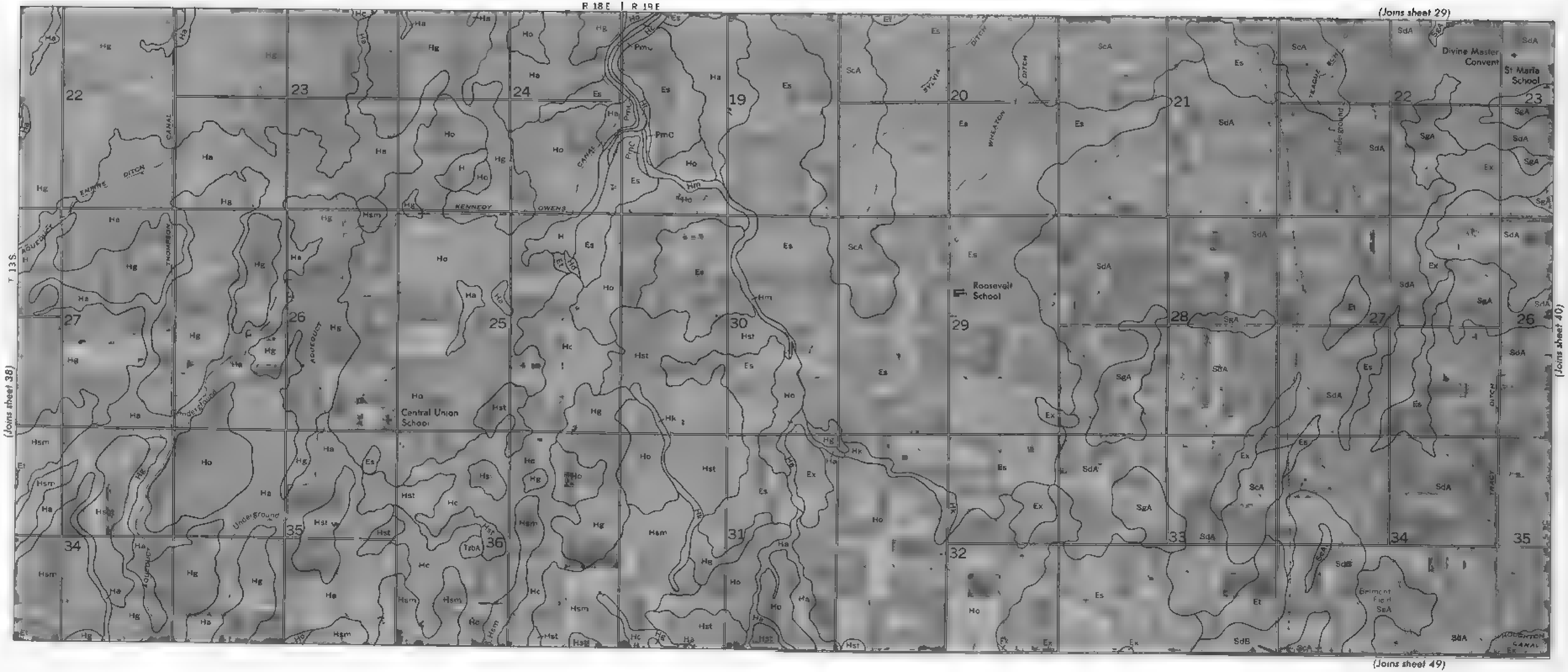
EASTERN FRESNO AREA, CALIFORNIA NO. 38

Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA NO. 39

N



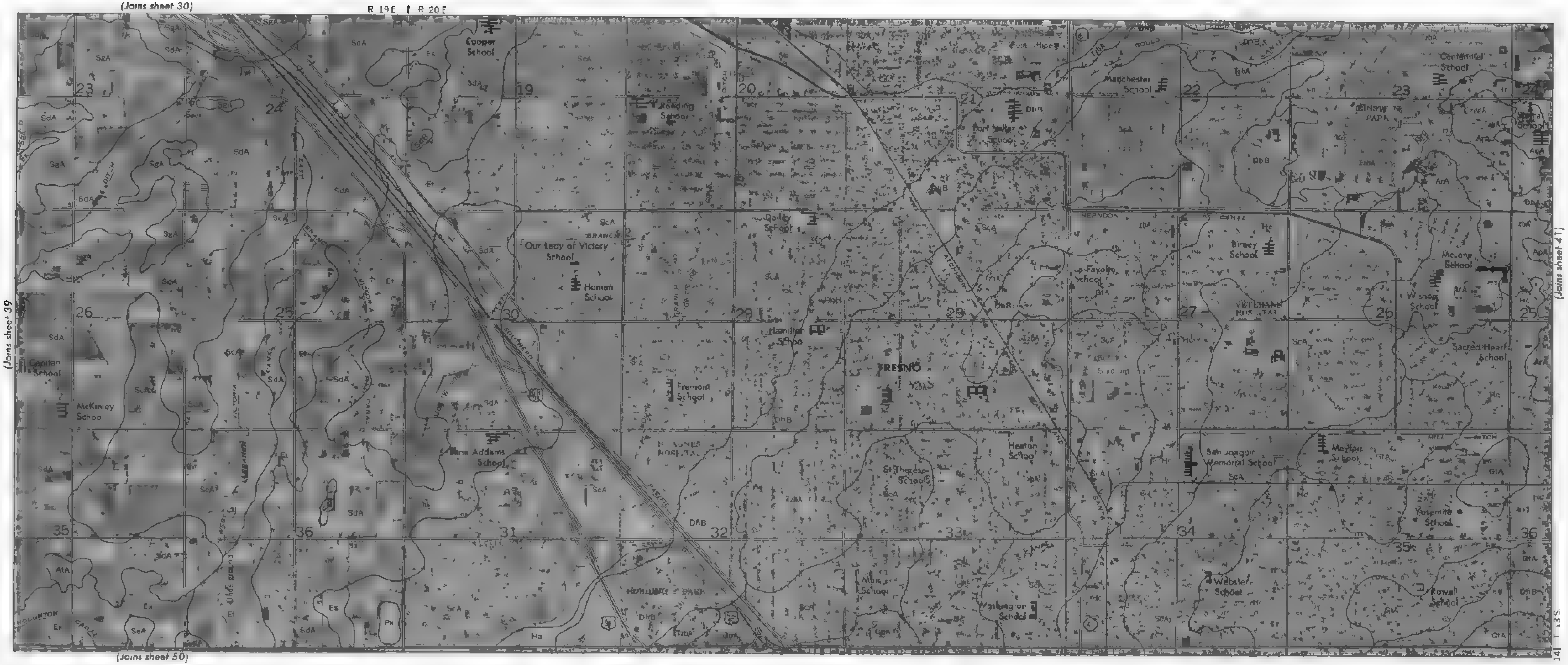
Scale 1:24000

0 ¼ ½ ¾ 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 40

N



Scale 1:24 000

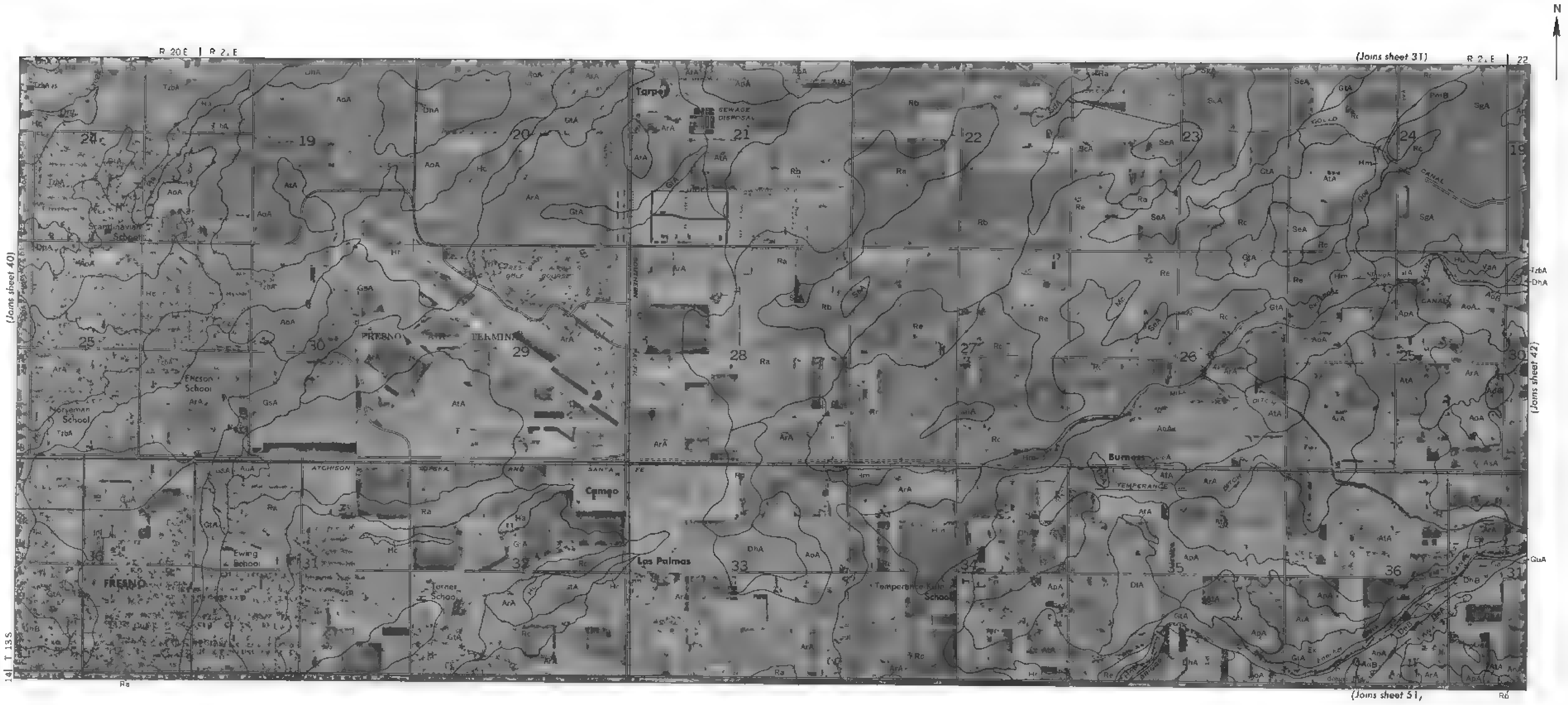
5000 4000 3000 2000 1000 0 5000 10 000 Feet

2 Miles

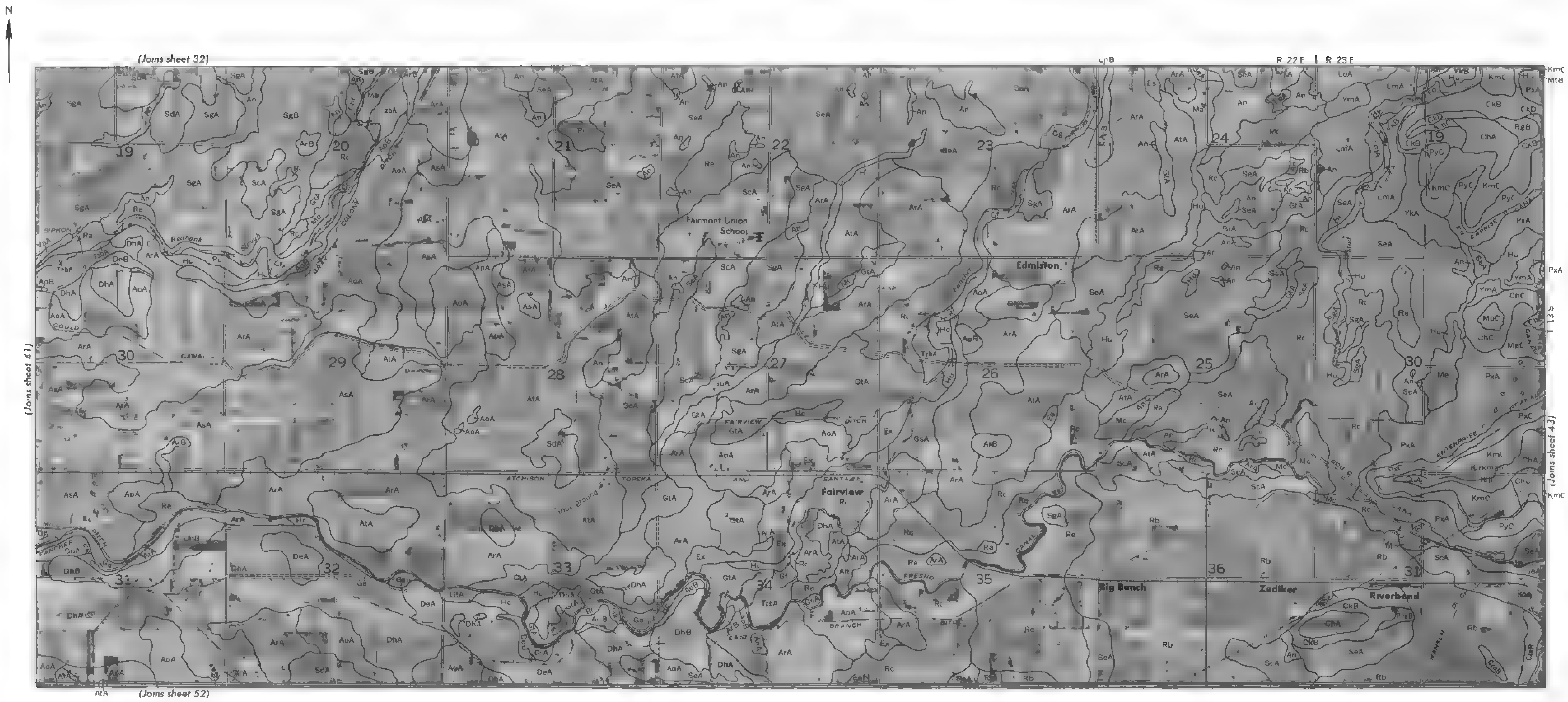
EASTERN FRESNO AREA, CALIFORNIA NO. 40

Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station



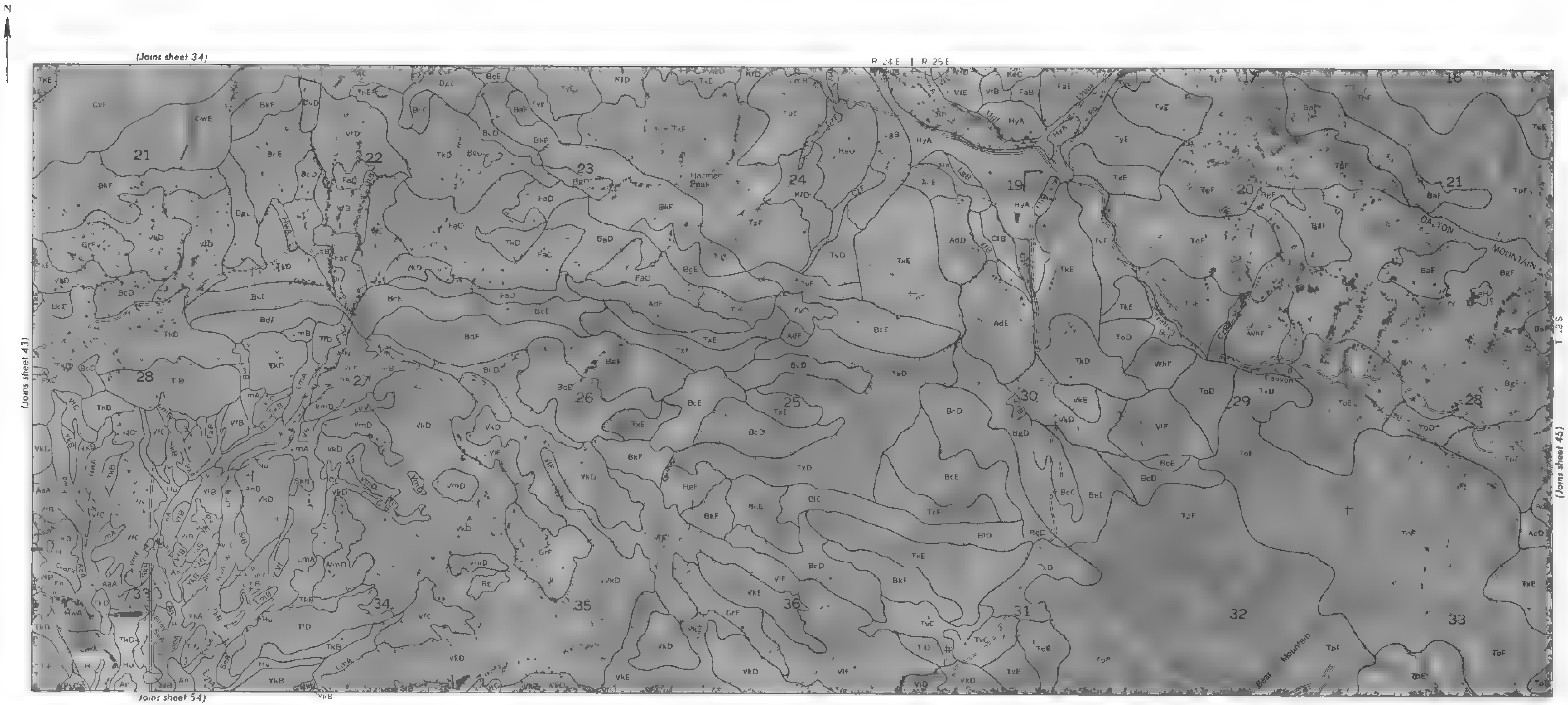
Scale 1:24 000



Scale 1:24000

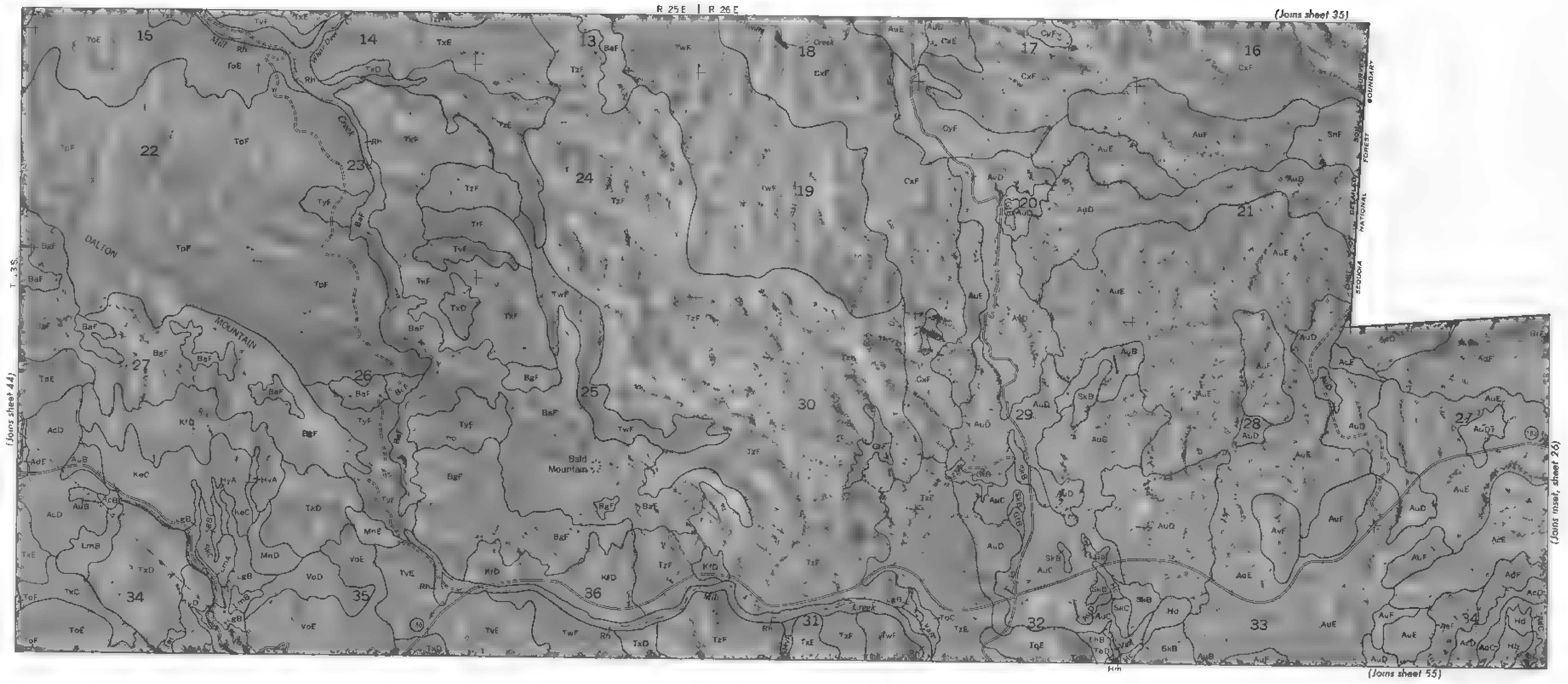
Scale 1:24 000

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 44



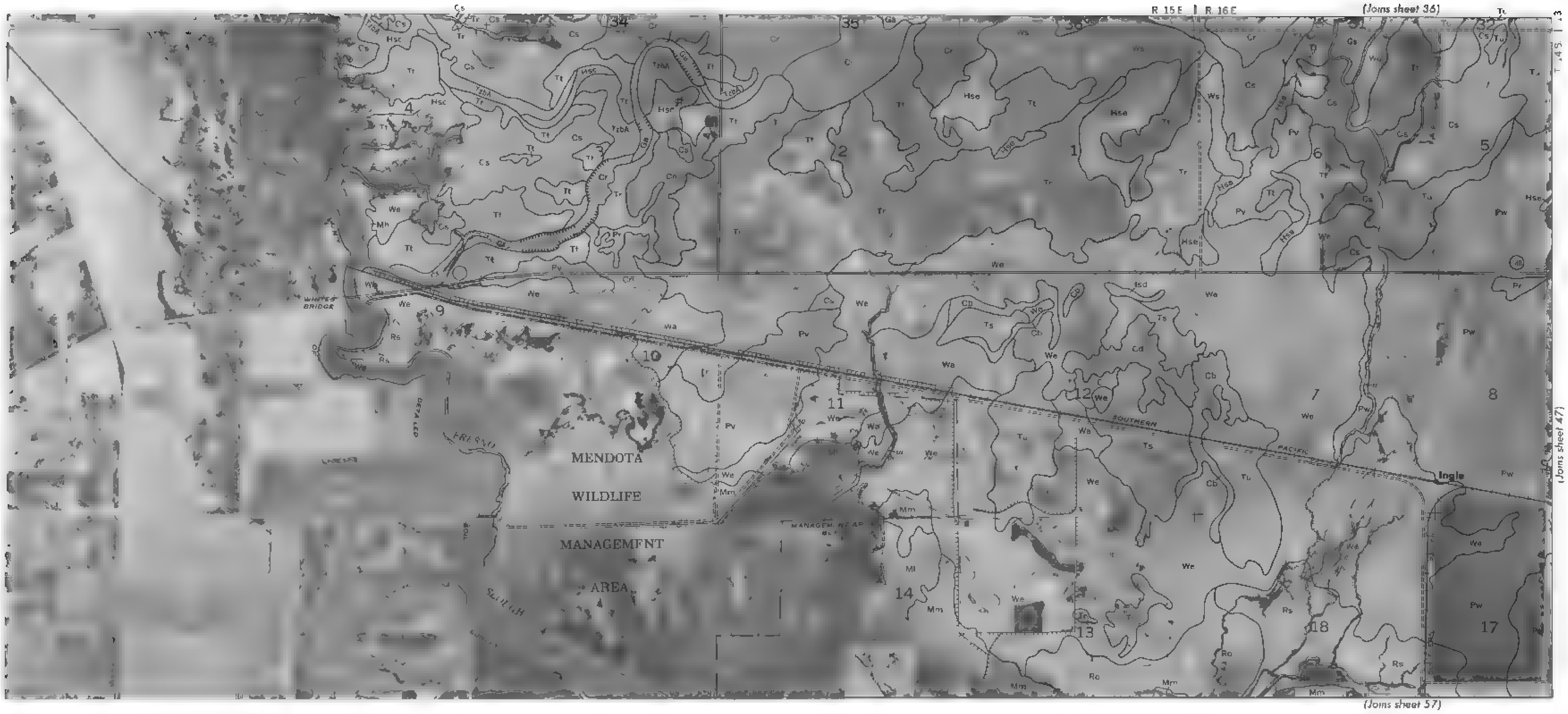
Scale 1:24 000

EASTERN FRESNO AREA, CALIFORNIA — SHEET NO. 44



Scale 1:24 000

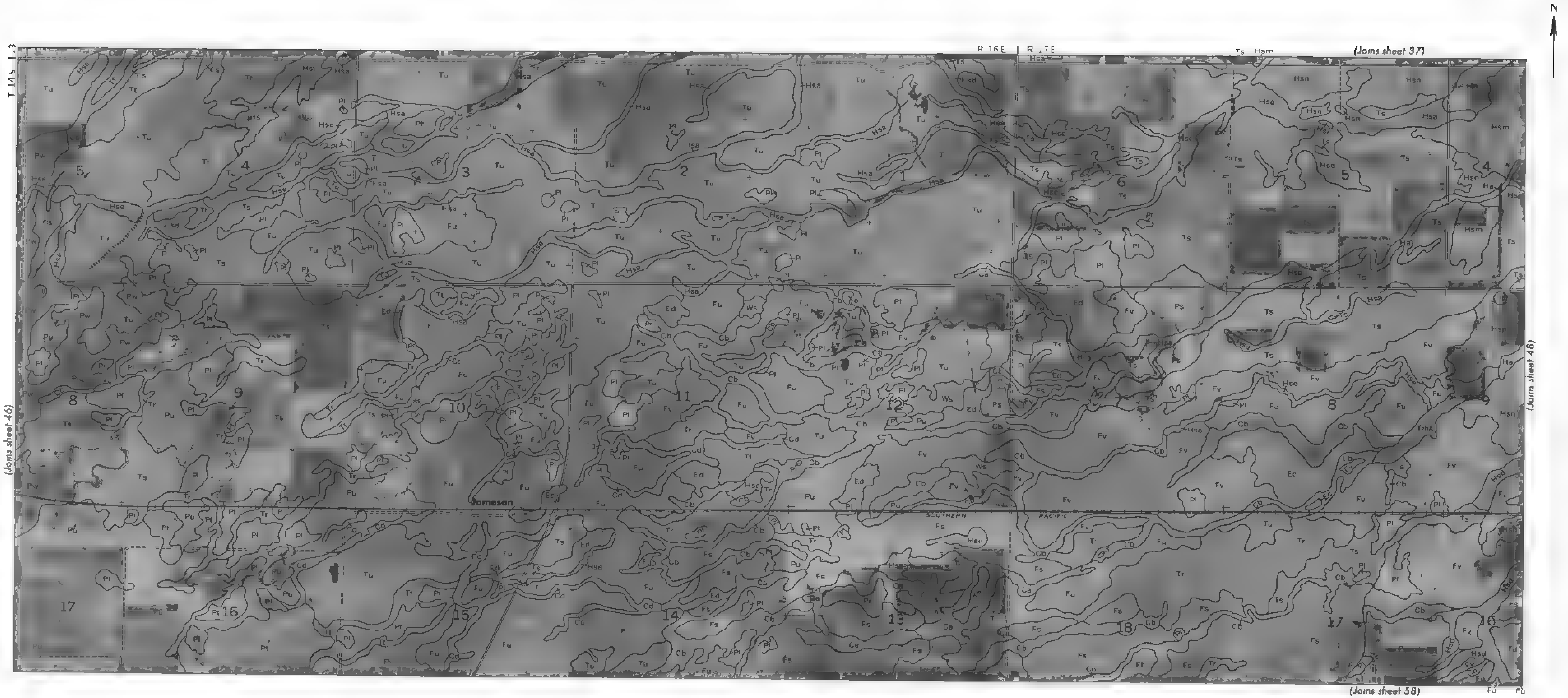
N



Scale 1:24 000

5000 4000 3000 2000 1000 0 5000 Feet

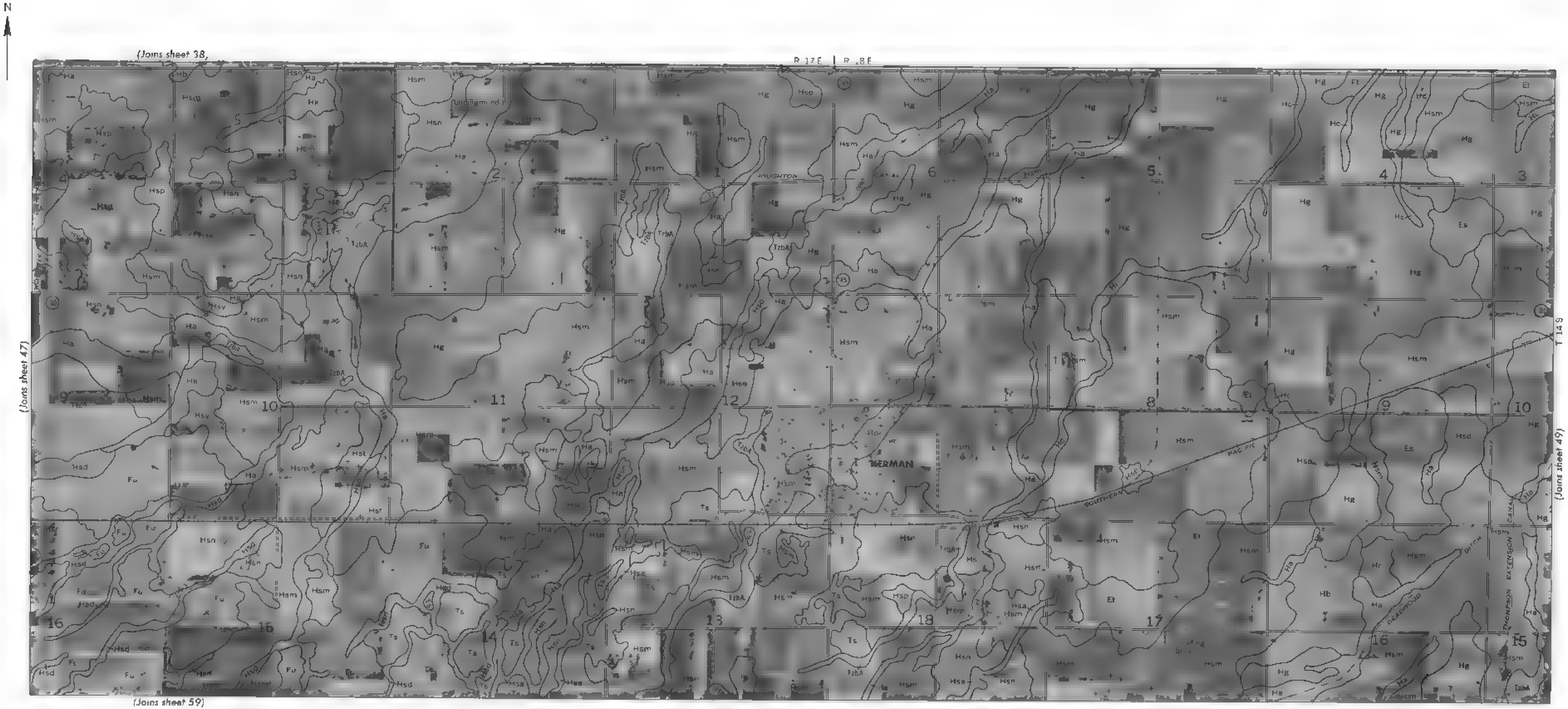
Land division corners are approximately positioned on this map



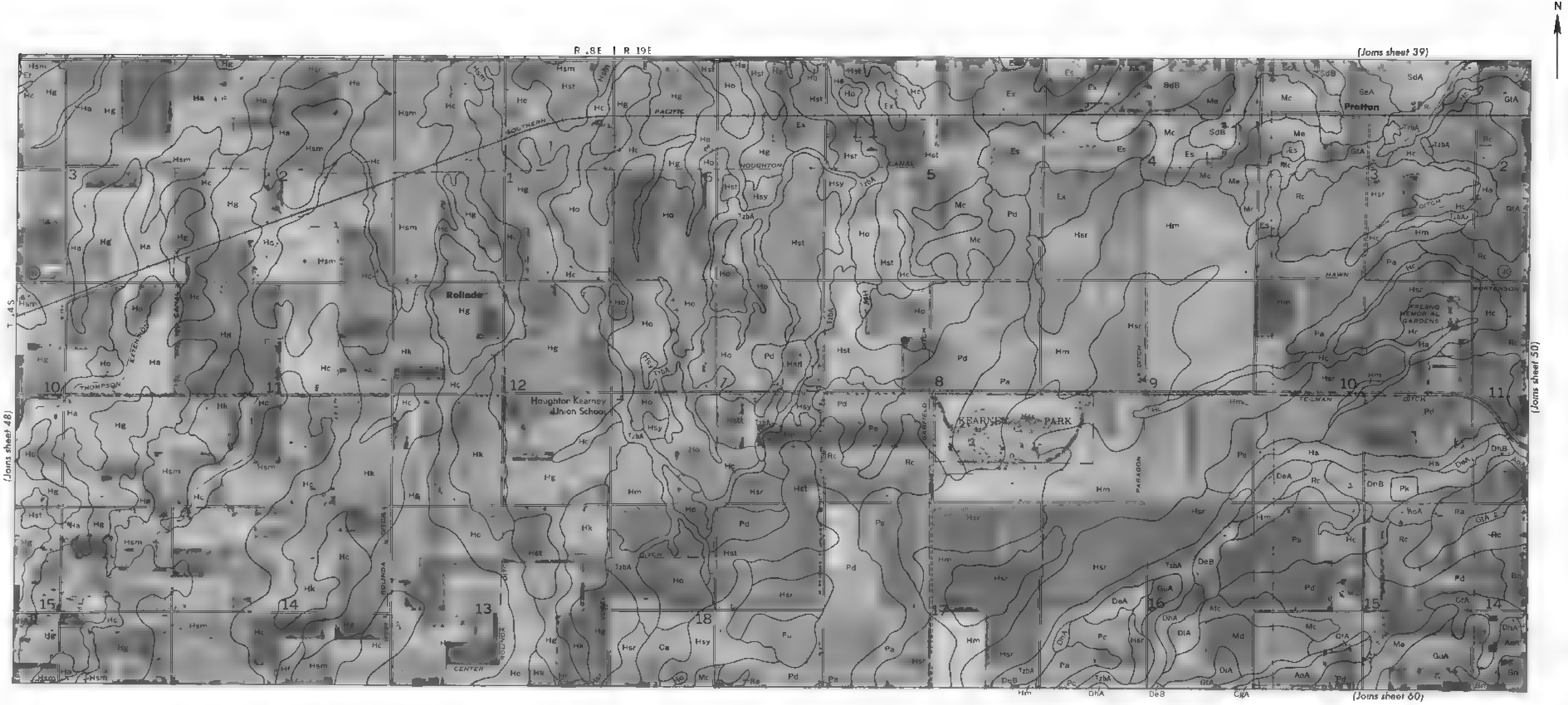
Scale 1:24000

5000 Feet

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 48



Scale 1:24000



Scale 1:24000

Scale 1:24 000

5000 4000 3000 2000 1000 0 5000 10000 Feet

EASTERN FRESNO AREA, CALIFORNIA NO. 50

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

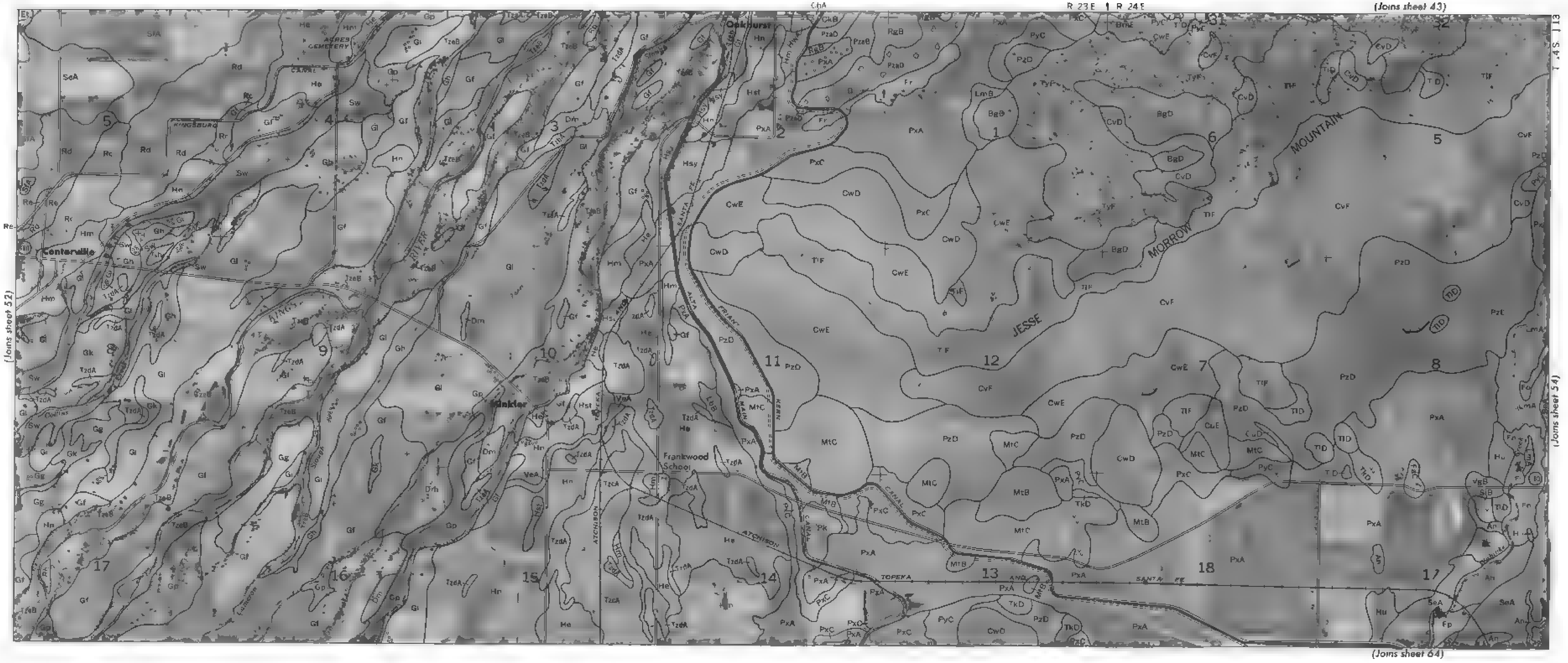
EASTERN FRESNO AREA, CALIFORNIA

Scale 1:24 000

EASTERN FRESNO AREA, CALIFORNIA NO. 52

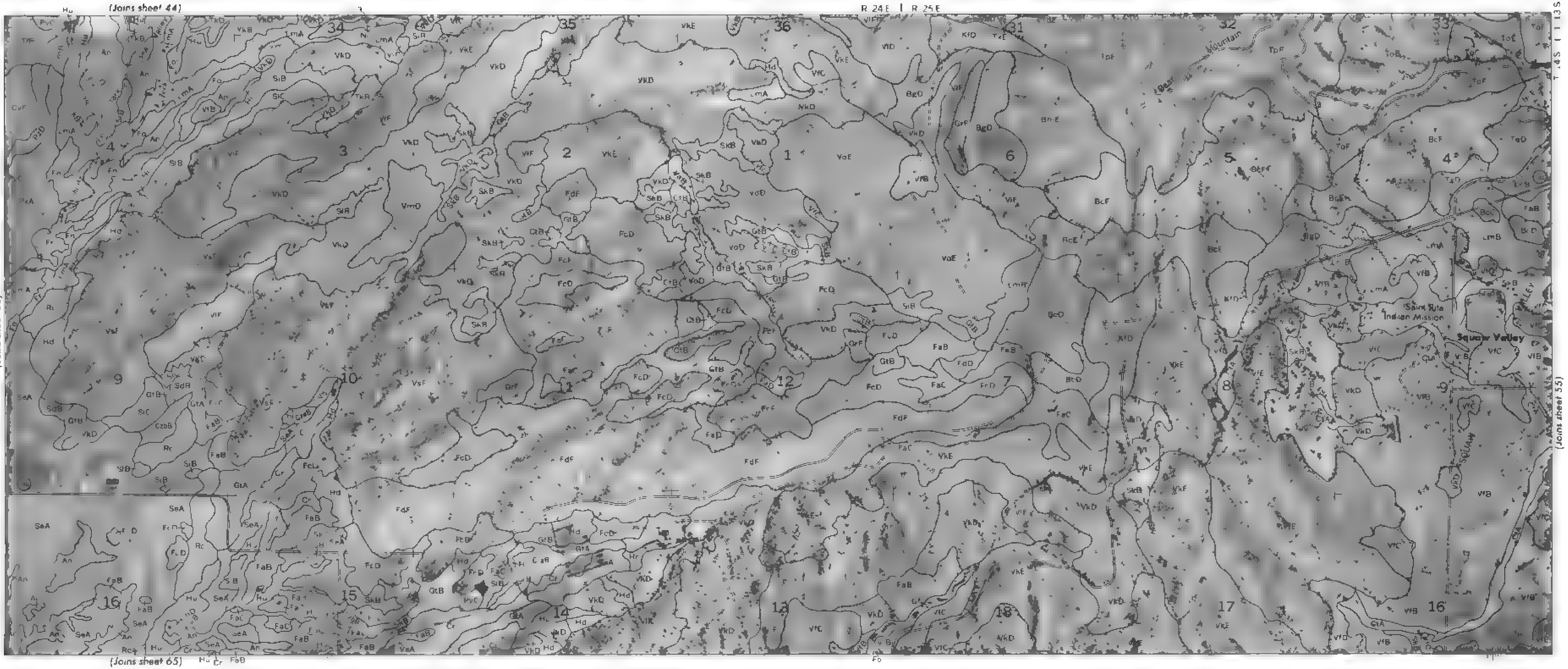
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.



Scale 1:24000

N

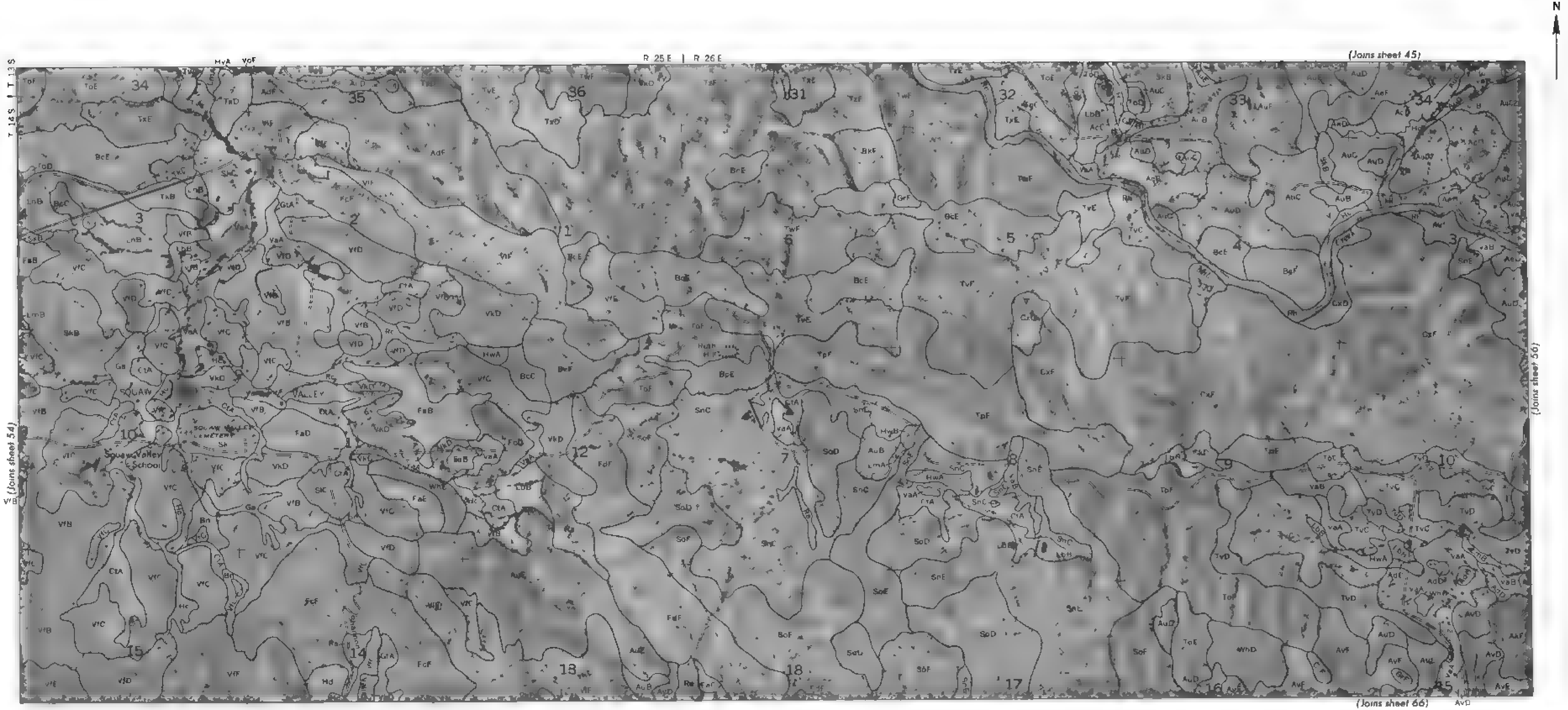


Scale 1:24 000

EASTERN FRESNO AREA, CALIFORNIA 54

Land divisions corners are approximately positioned on this map

This map is one of a set compiled in [illegible] as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station

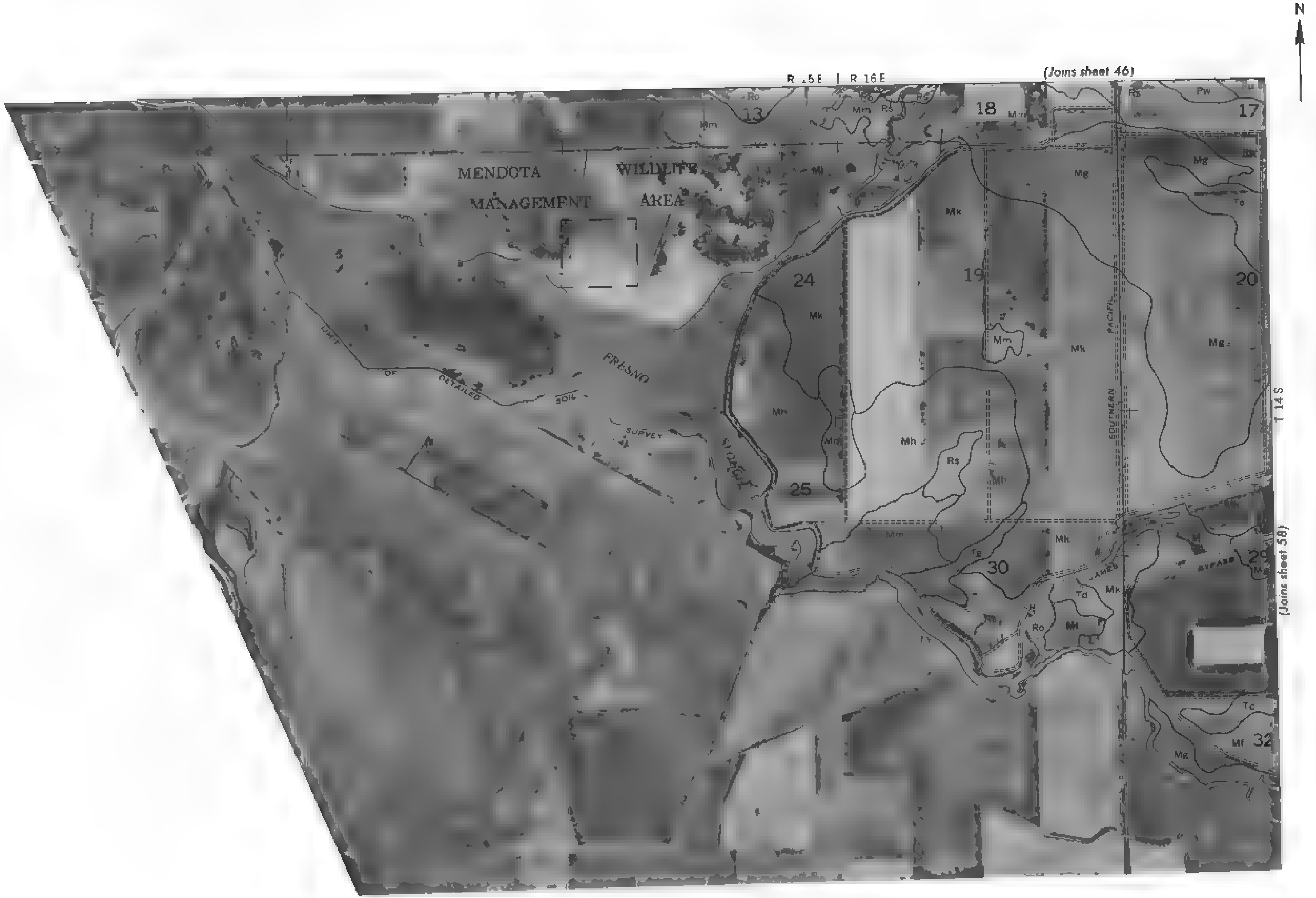


Scale 1:24000

EASTERN FRESNO AREA, CALIFORNIA NO. 56

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.



Scale 1:24 000

6000 4000 3000 2000 1000 0 5000 10000 Feet

Miles

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

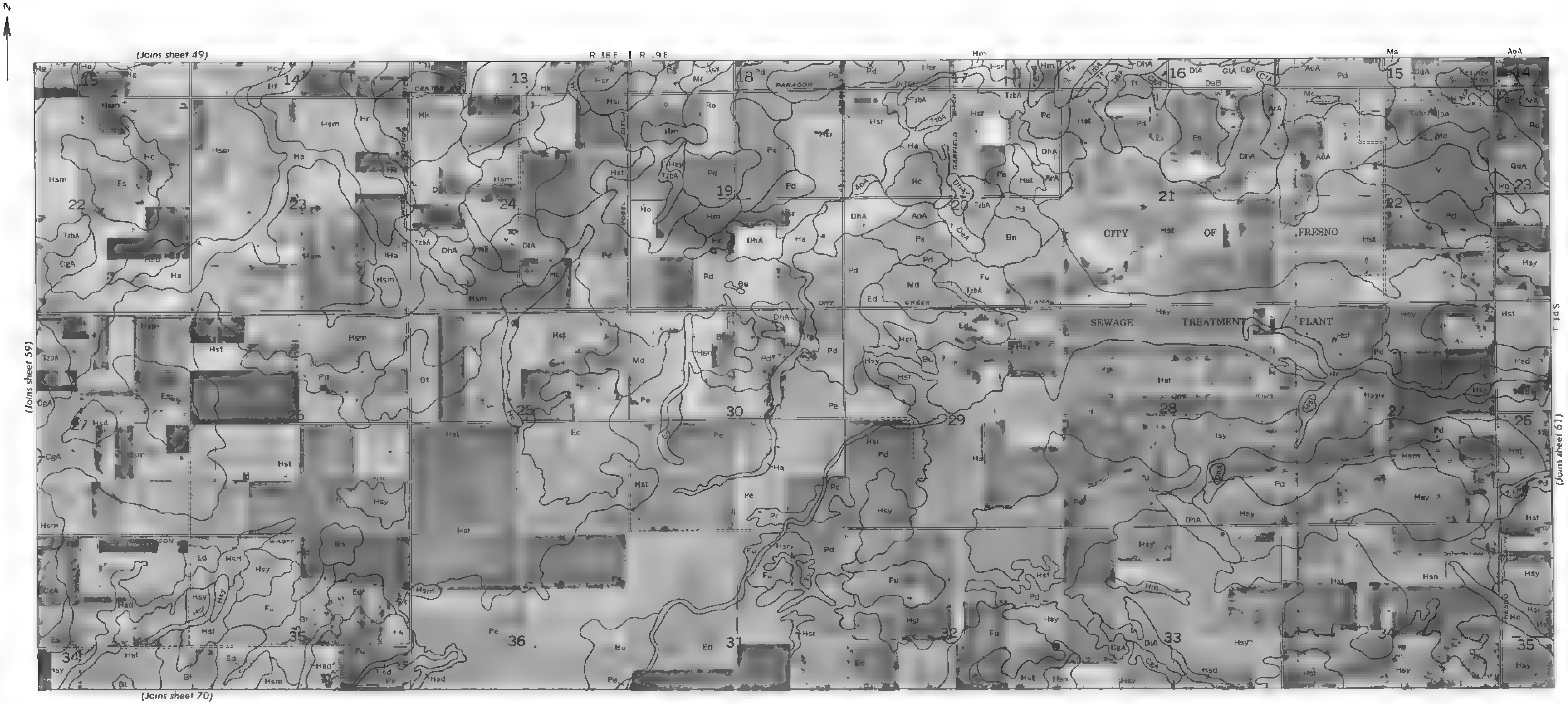
EASTERN FRESNO AREA, CALIFORNIA NO. 57

EASTERN FRESNO AREA, CALIFORNIA NO. 58

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.

and division corners are approximately positioned on this map


(Joins sheet 48)
(Joins sheet 58)
(Joins sheet 60)
(Joins sheet 69)
N
Scale 1:24000



Scale 1:24000

1 Mile ½ 0 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.

Scale 1:24 000

Scale 1:24 000

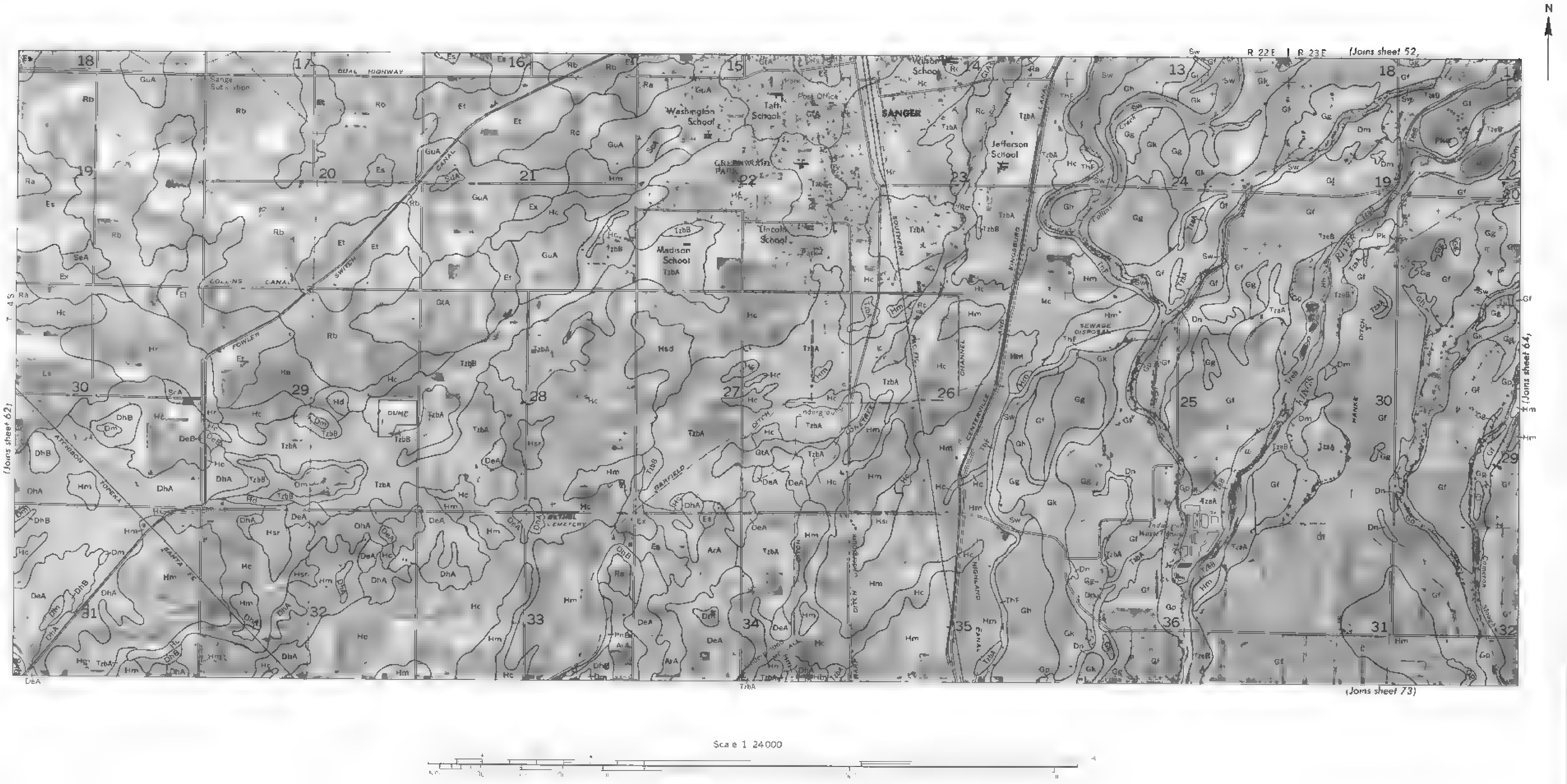
2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

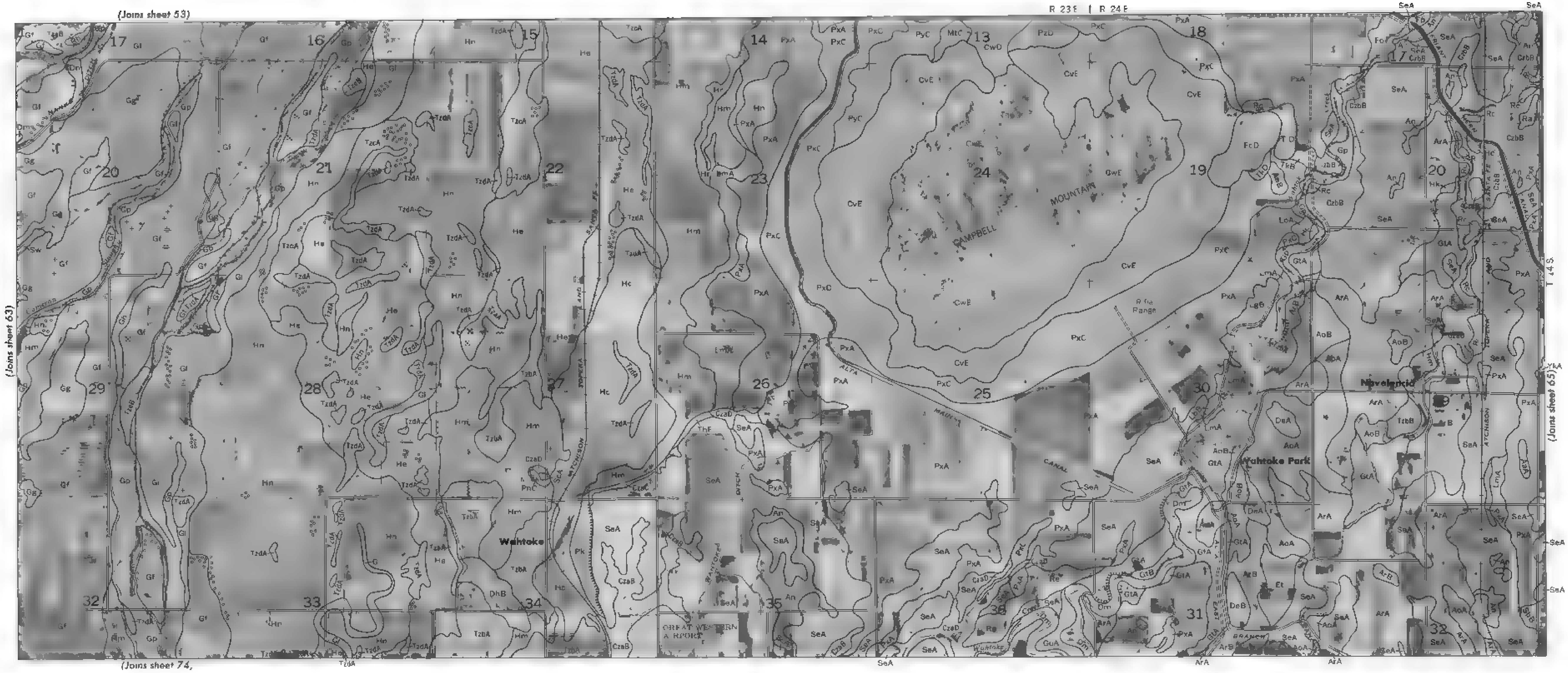
EASTERN FRESNO AREA, CALIFORNIA NO. 62

Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station



(Joins sheet 52)
R 22 E
R 23 E
(Joins sheet 62)
(Joins sheet 64)
(Joins sheet 73)
N
SANGER
Washington School
Taft School
Post Office
Jefferson School
Lincoln School
Madison School
GREENWAIR PARK
Sanger Substation
DUAL HIGHWAY
COLLINS CANAL
FOWLER SWITCH CANAL
KINGSBURG
CENTERVILLE AND KINGSBURG CANAL
SOUTHERN PACIFIC
ATCHISON TOPEKA AND SANTA FE
GARFIELD
SEWAGE DISPOSAL
KINGS RIVER
DUMP
CEMETERY
HIGHLAND CANAL
Scale 1:24 000

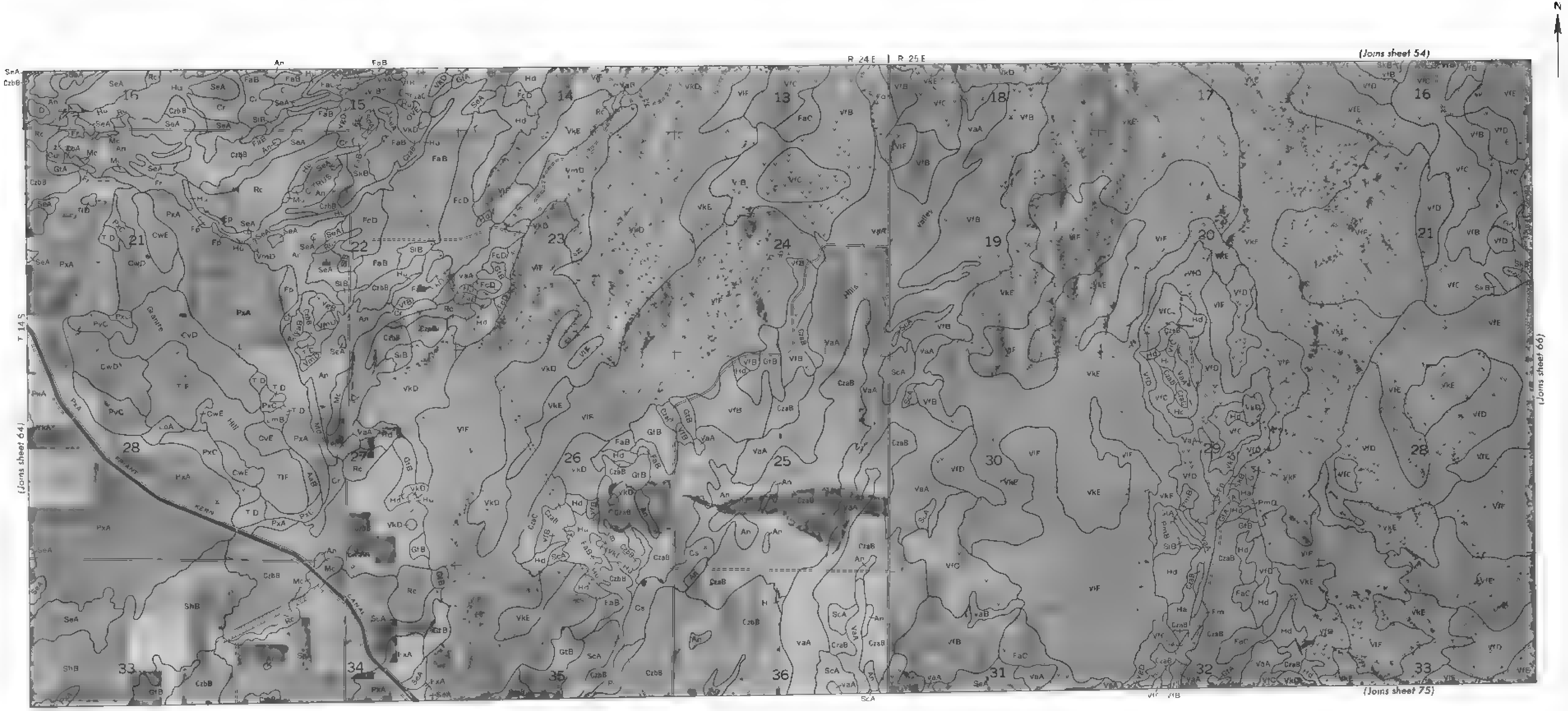


Scale 1 24000

EASTERN FRESNO AREA, CA., FORM A NO. 64

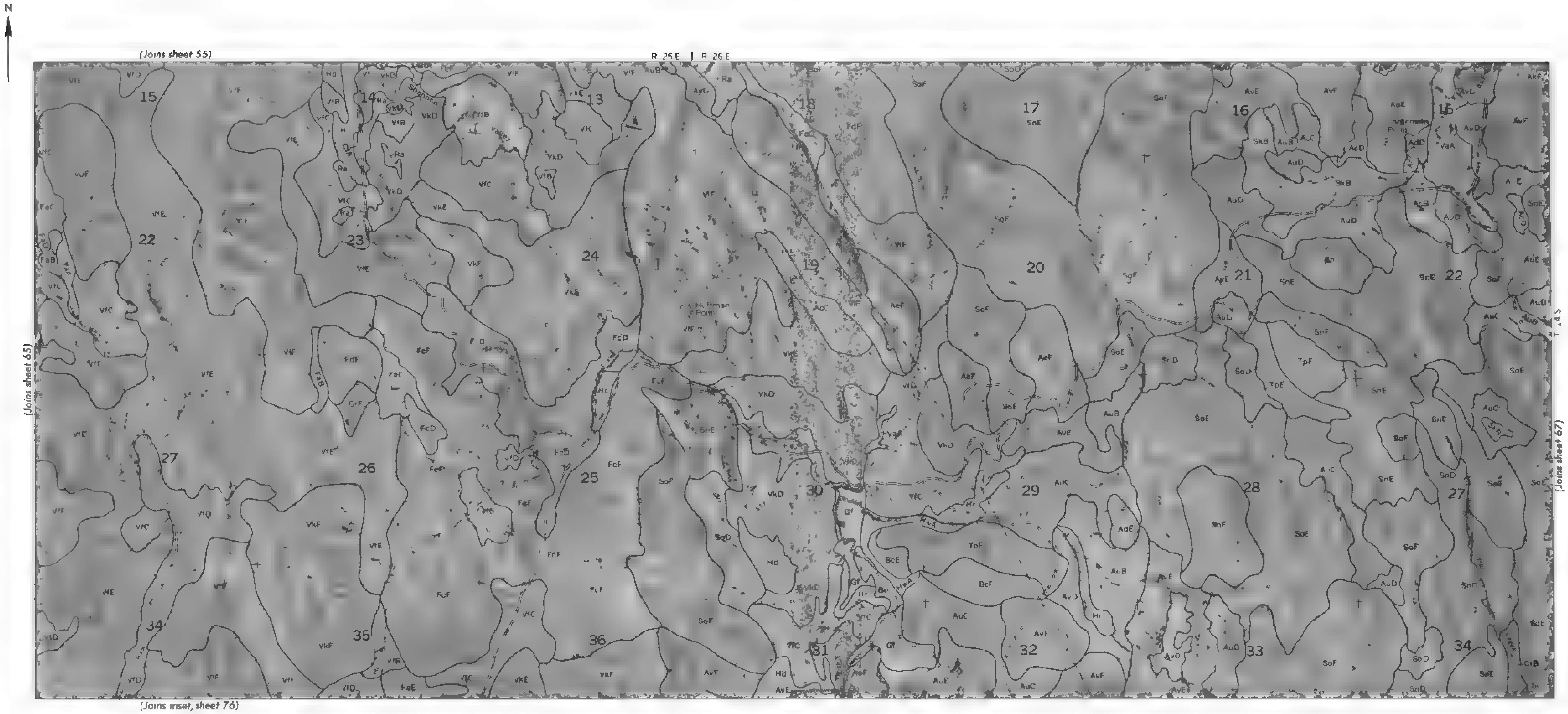
Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station



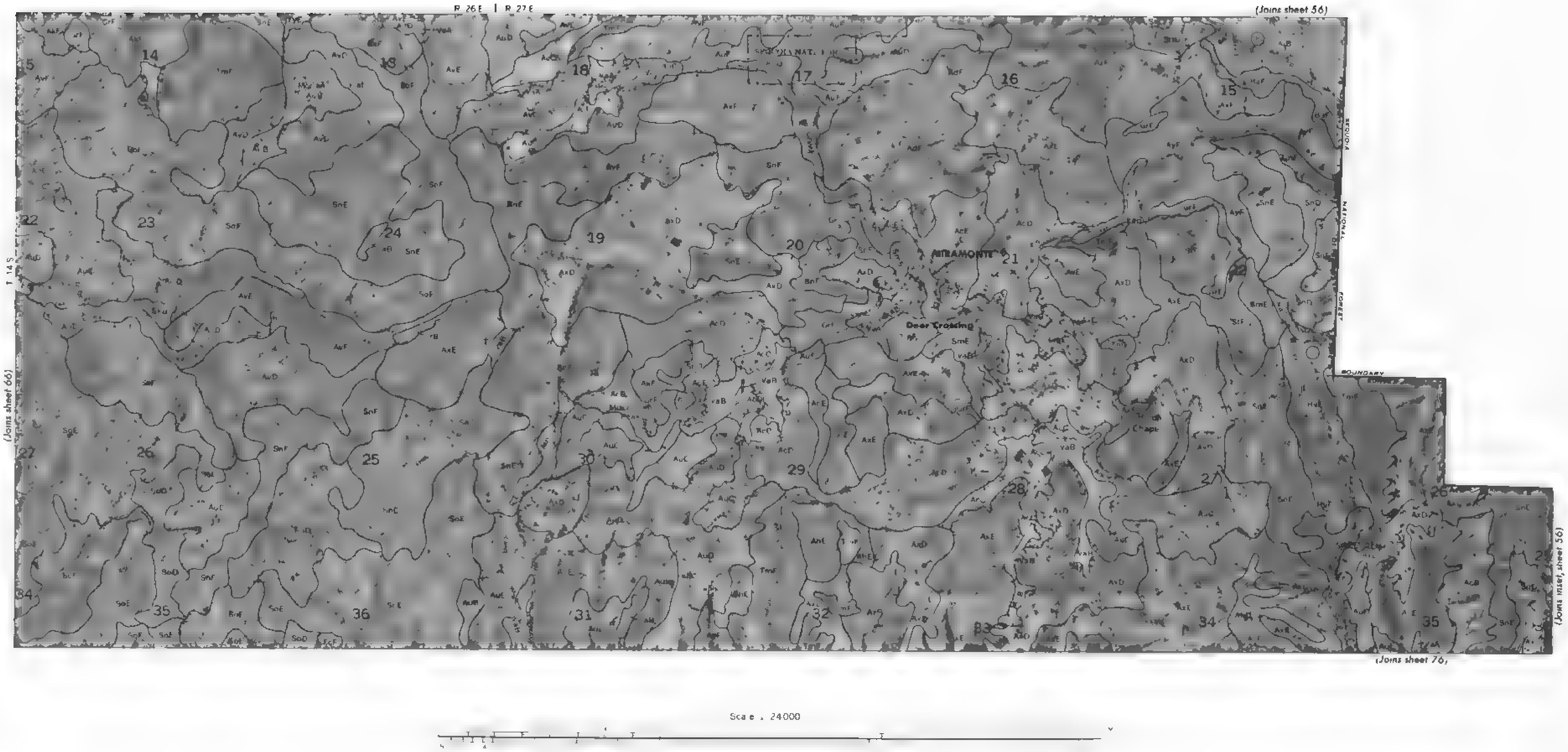
Scale 1:24 000

EASTERN FRESNO AREA CALIFORNIA — SHEET NUMBER 66



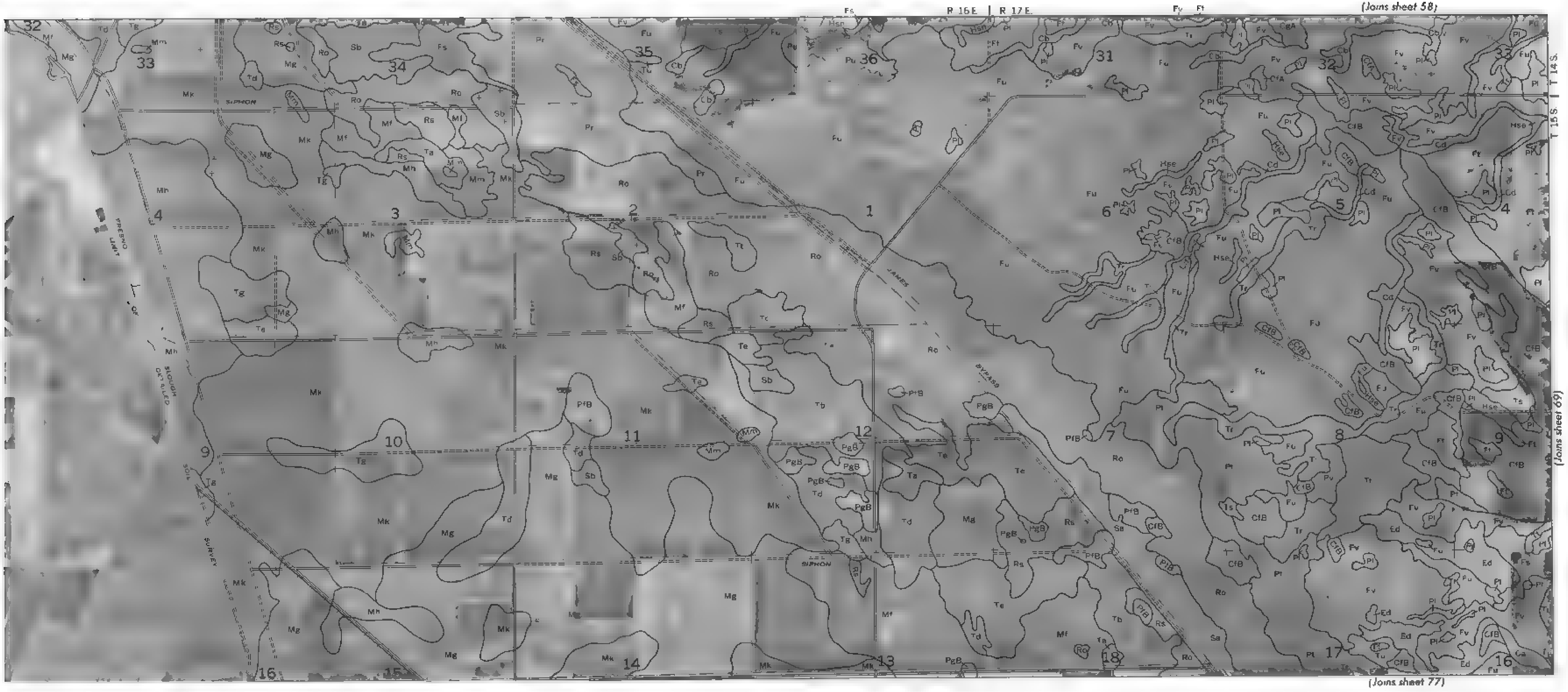
Scale 1:24 000

EASTERN FRESNO AREA, CALIFORNIA NO. 66


R 26 E
R 27 E
(Joins sheet 56)
(Joins sheet 66)
(Joins sheet 76)
(Joins inset, sheet 56)
T 14 S
MIRAMONTE
Deer Crossing
Chapel
SEQUOIA NATIONAL FOREST BOUNDARY
N
Scale 1:24000

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 68

N



Scale 1:24 000

1 ¼ ½ 2 Miles

5000 4000 3000 2000 1000 0 5000 10 000 Feet

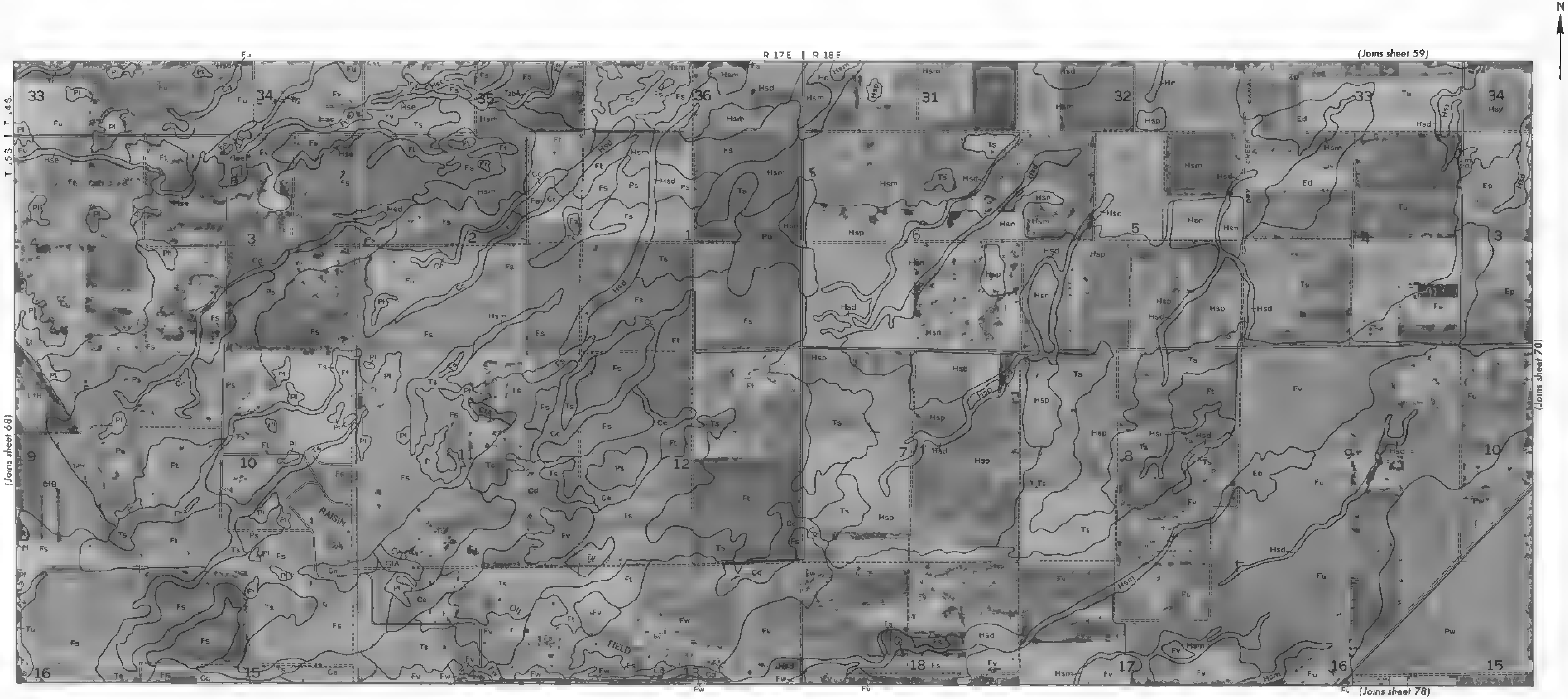
EASTERN FRESNO AREA, CALIFORNIA

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.

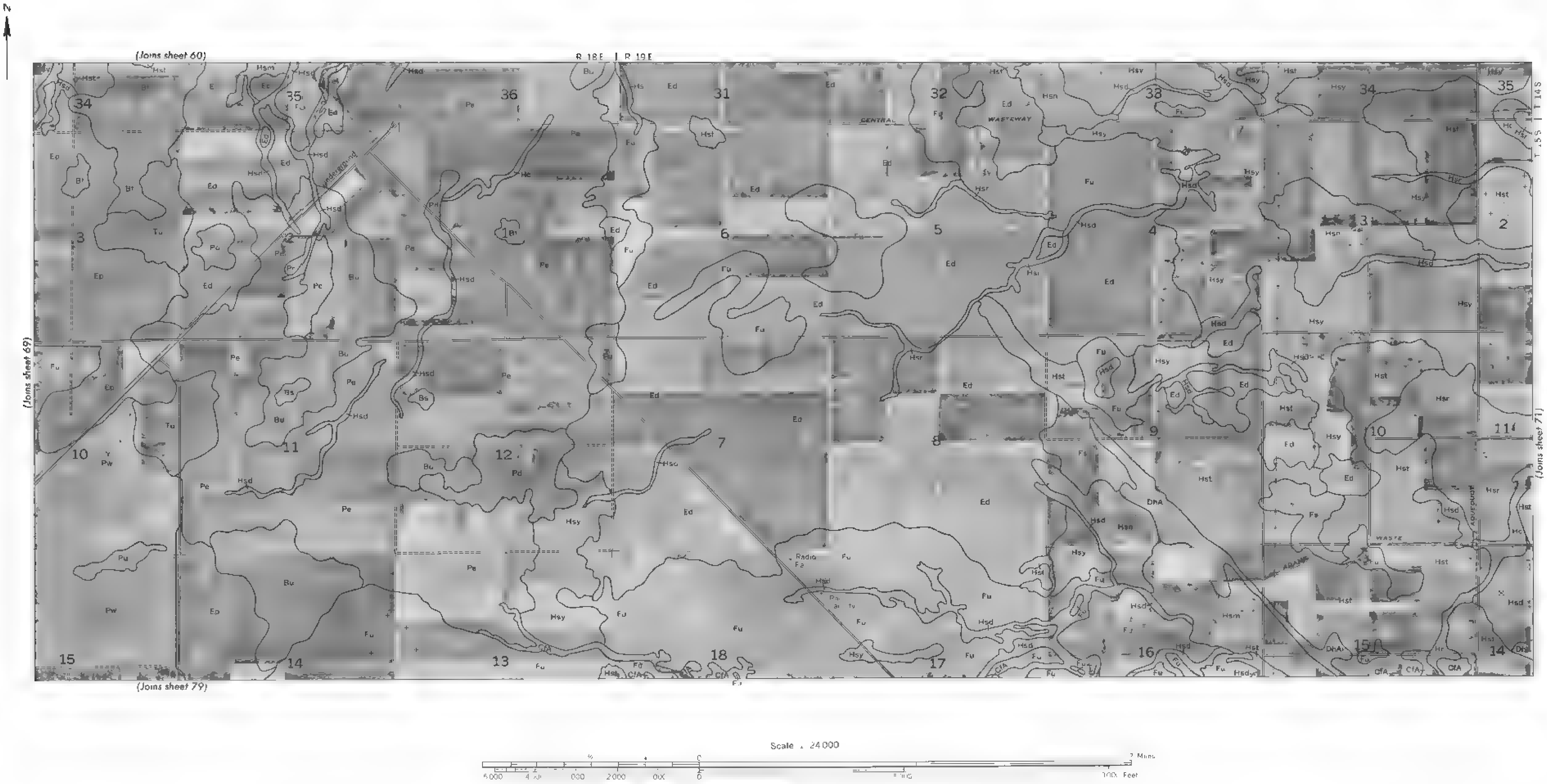
This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA NO. 69



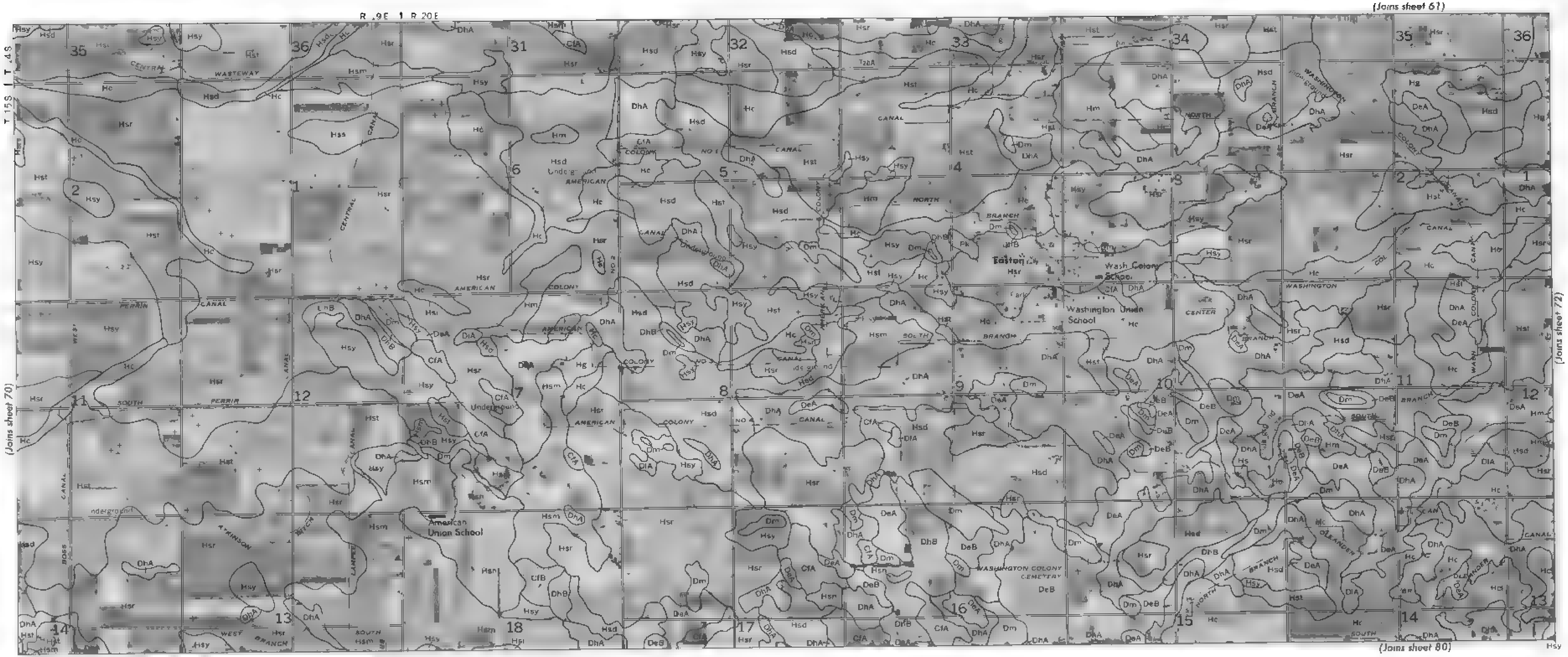
Scale 1:24 000

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 70



Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station



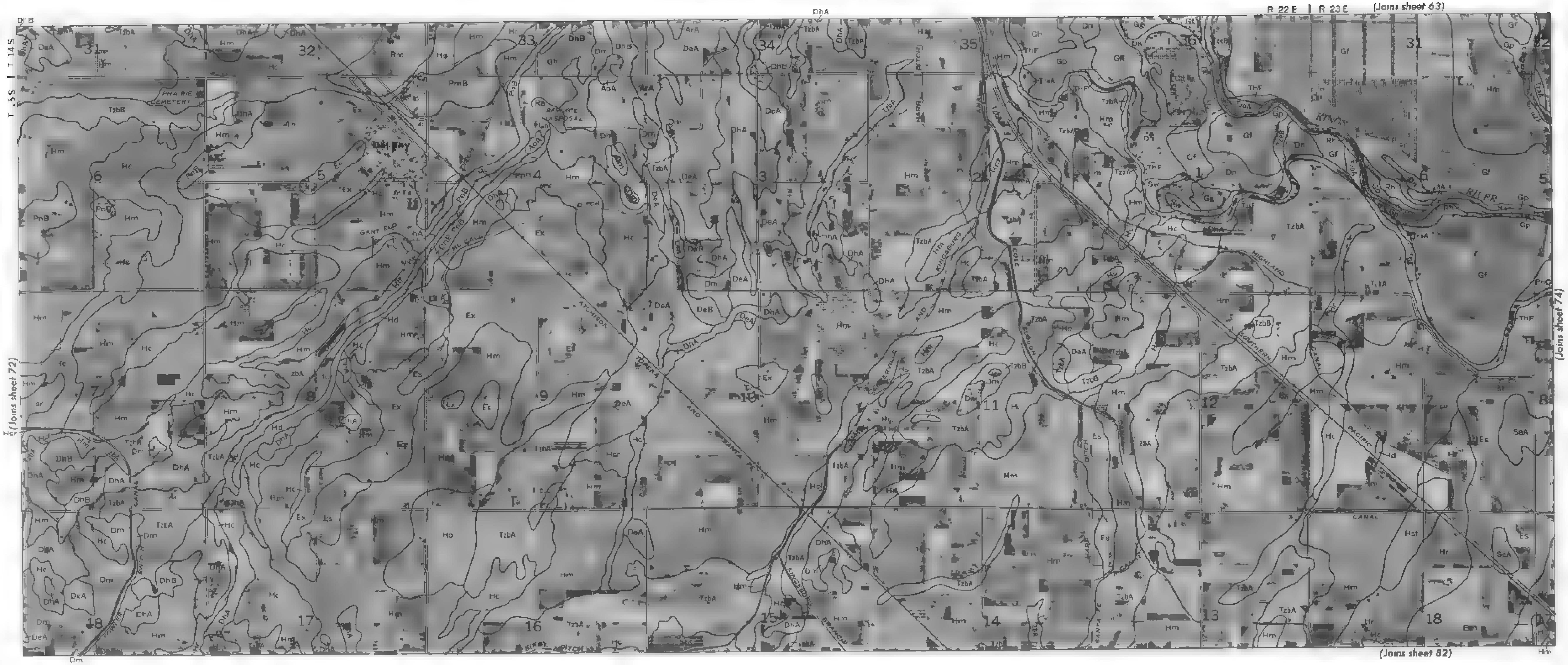
Land division corners are approximately positioned on this map

Scale 1:24 000

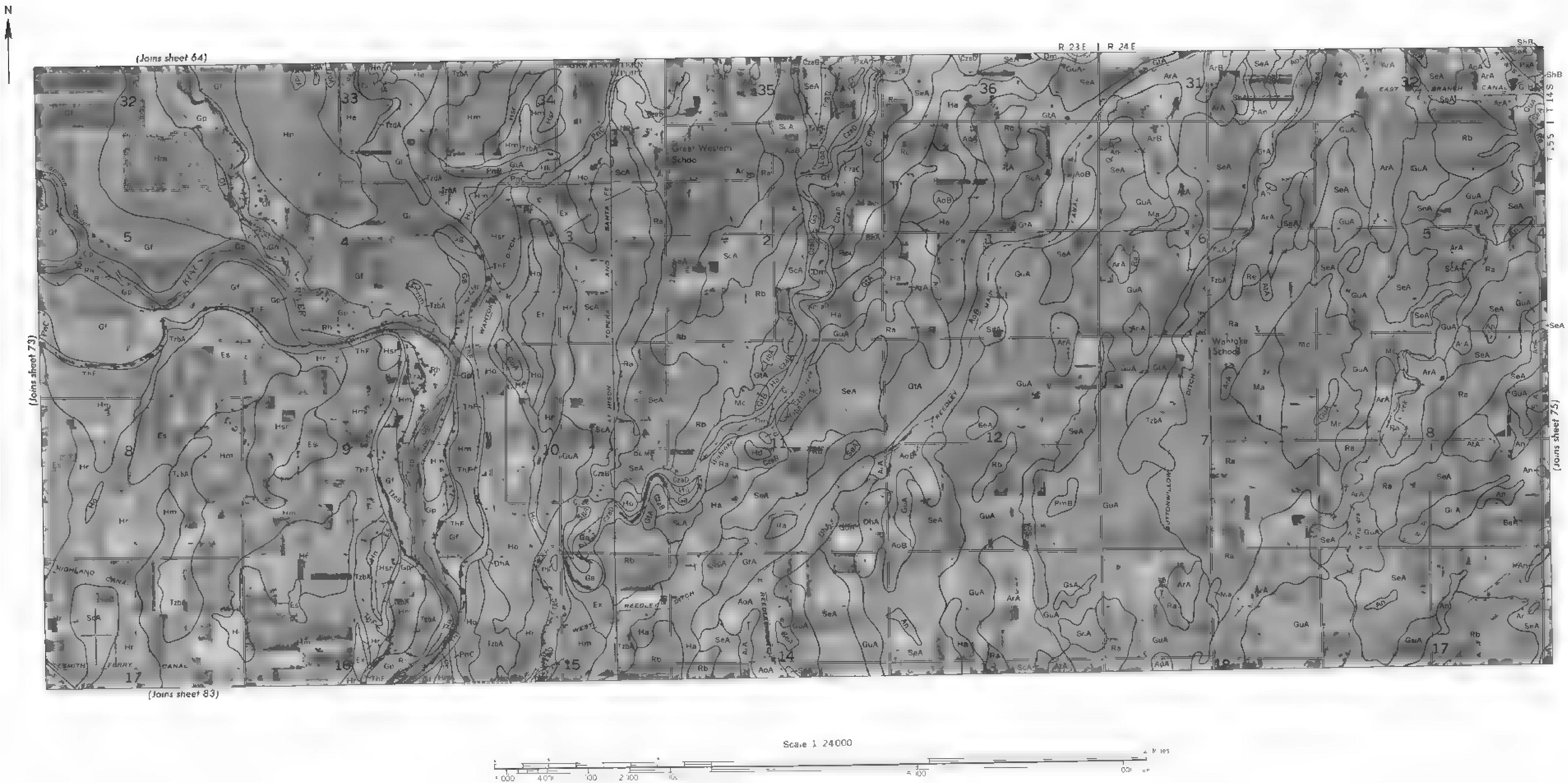
EASTERN FRESNO AREA, CALIFORNIA NO. 72

Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station



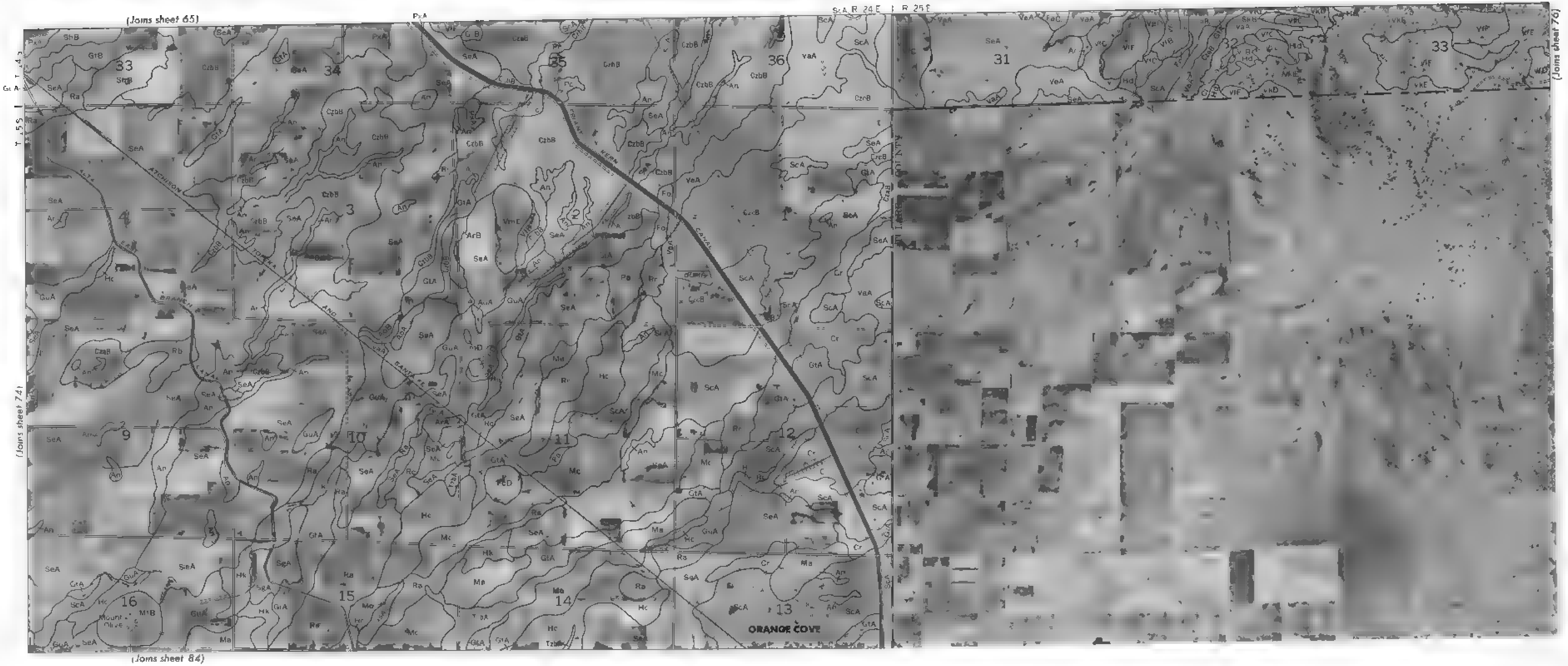
Scale 1:24 000



EASTERN FRESNO AREA, CALIFORNIA NO. 74

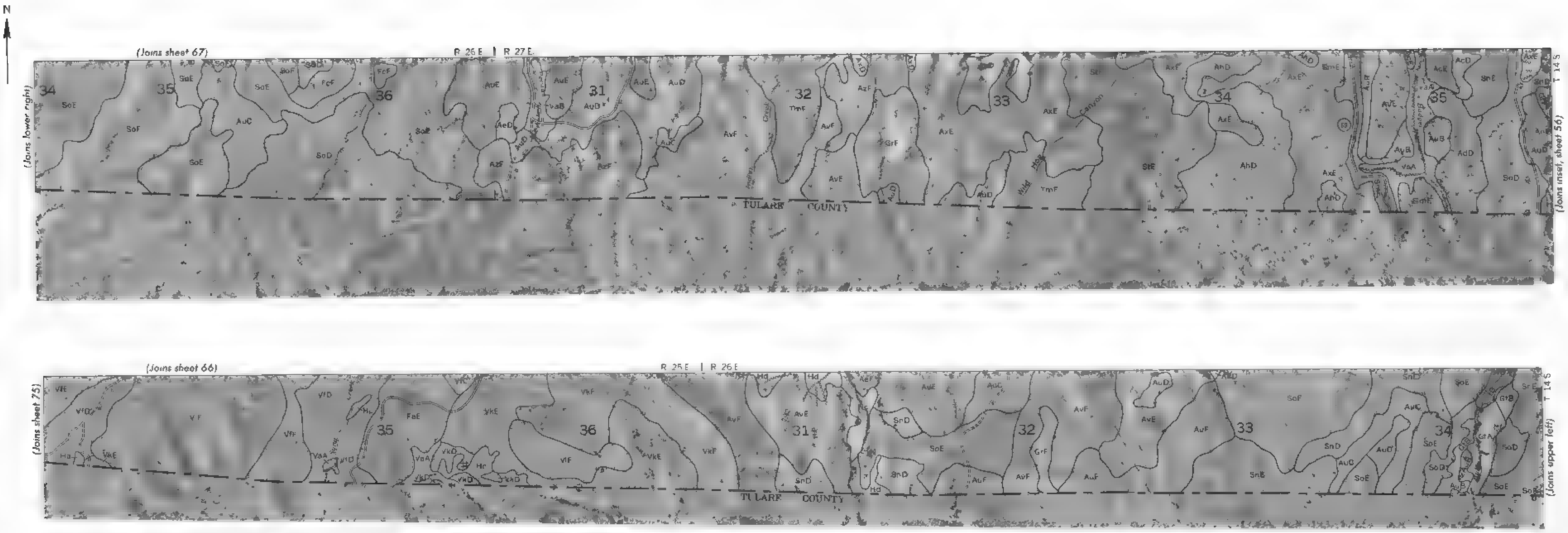
Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station



Scale 1:24 000

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 76



Scale 1:24 000

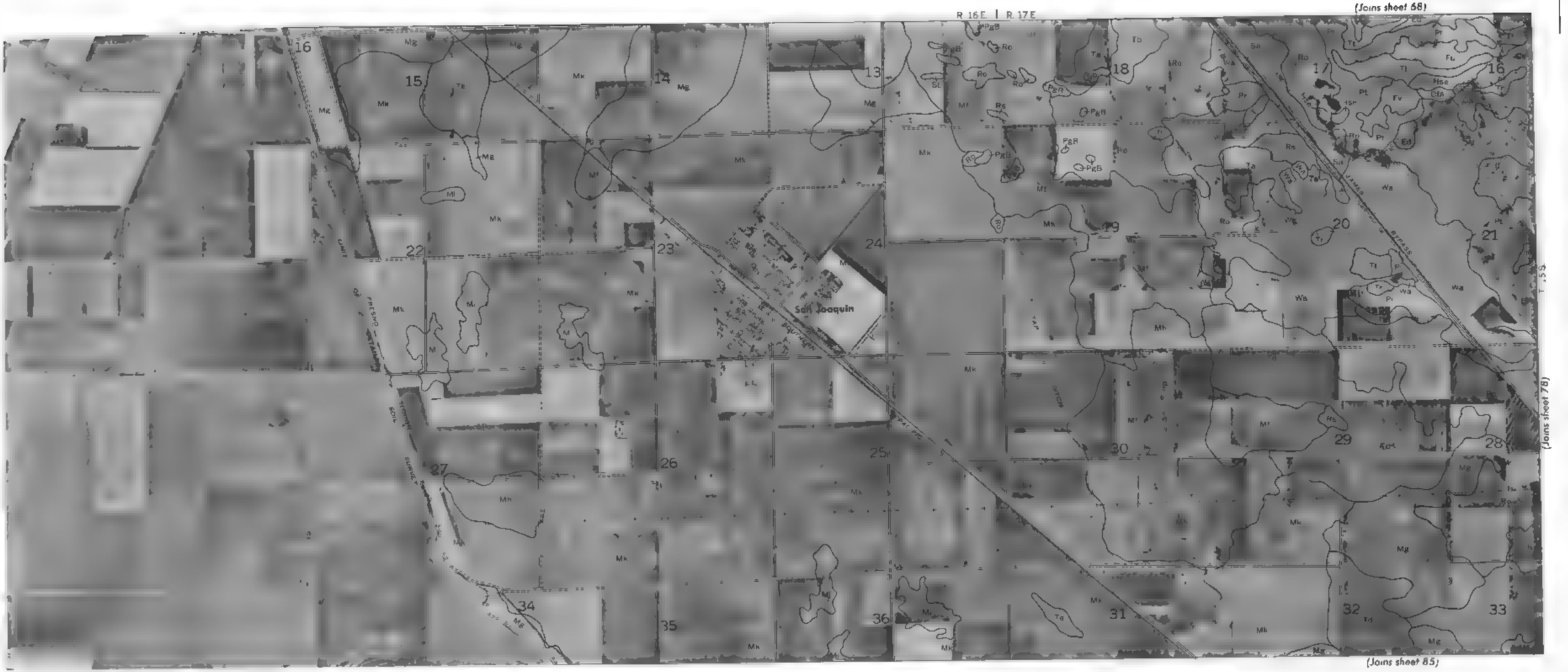
1 ½ 0 2 Miles

5000 4000 3000 2000 1000 0 5000 10 000 Feet

EASTERN FRESNO AREA, CALIFORNIA

Land division corners are approximately positioned on this map

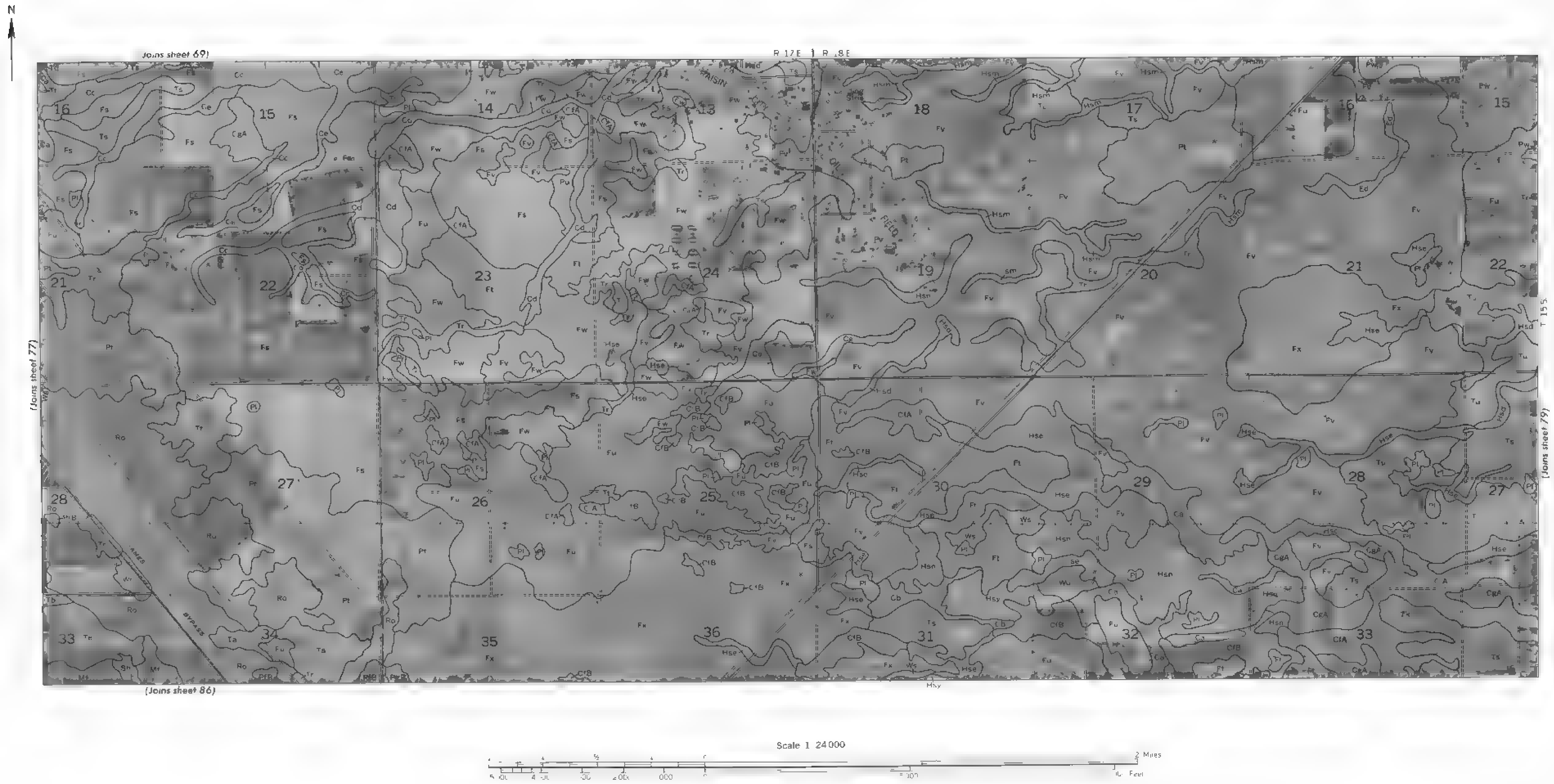
This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station



Scale 1:24 000

and division corners are approximately positioned on this map

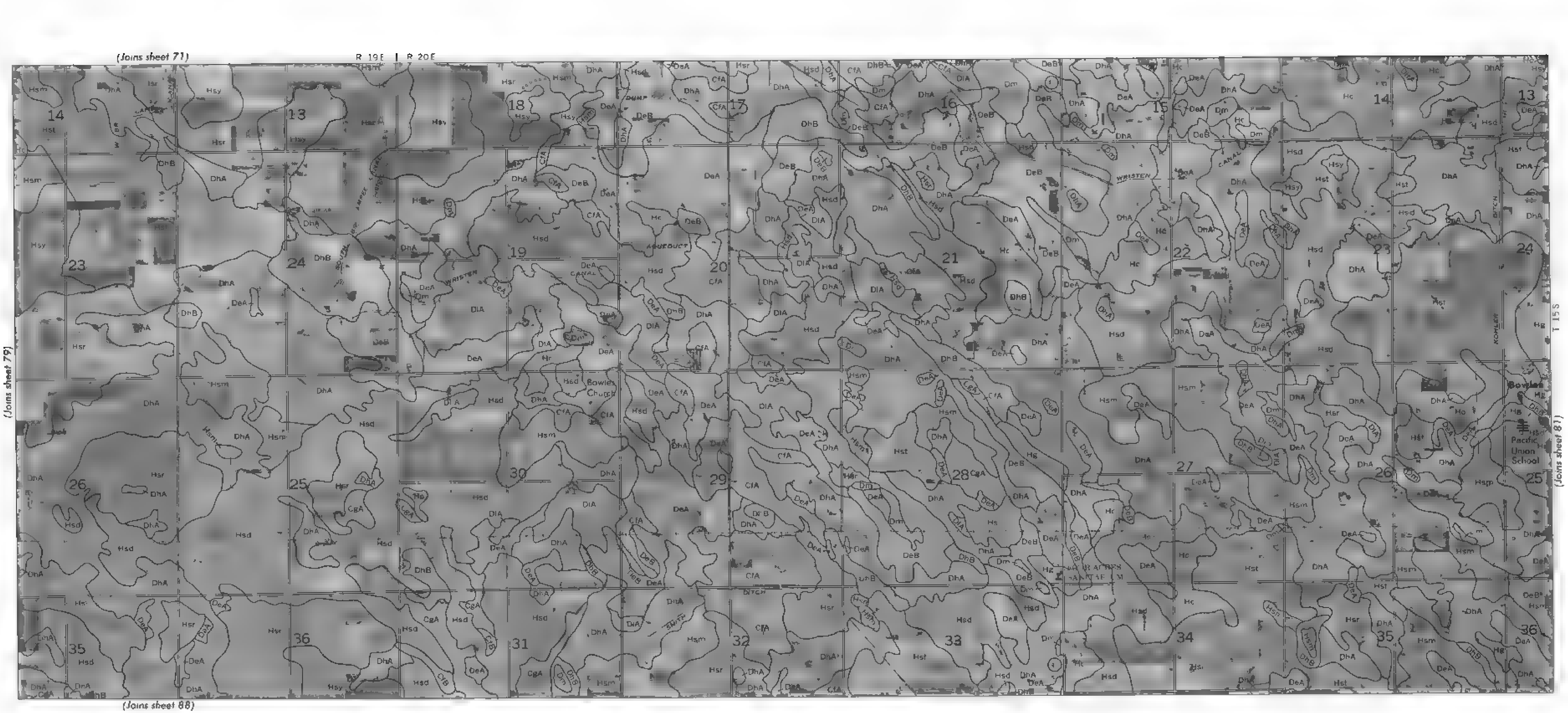
EASTERN FRESNO AREA, CALIFORNIA NO. 77



Scale 1 24 000

Scale 1:24 000

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 80

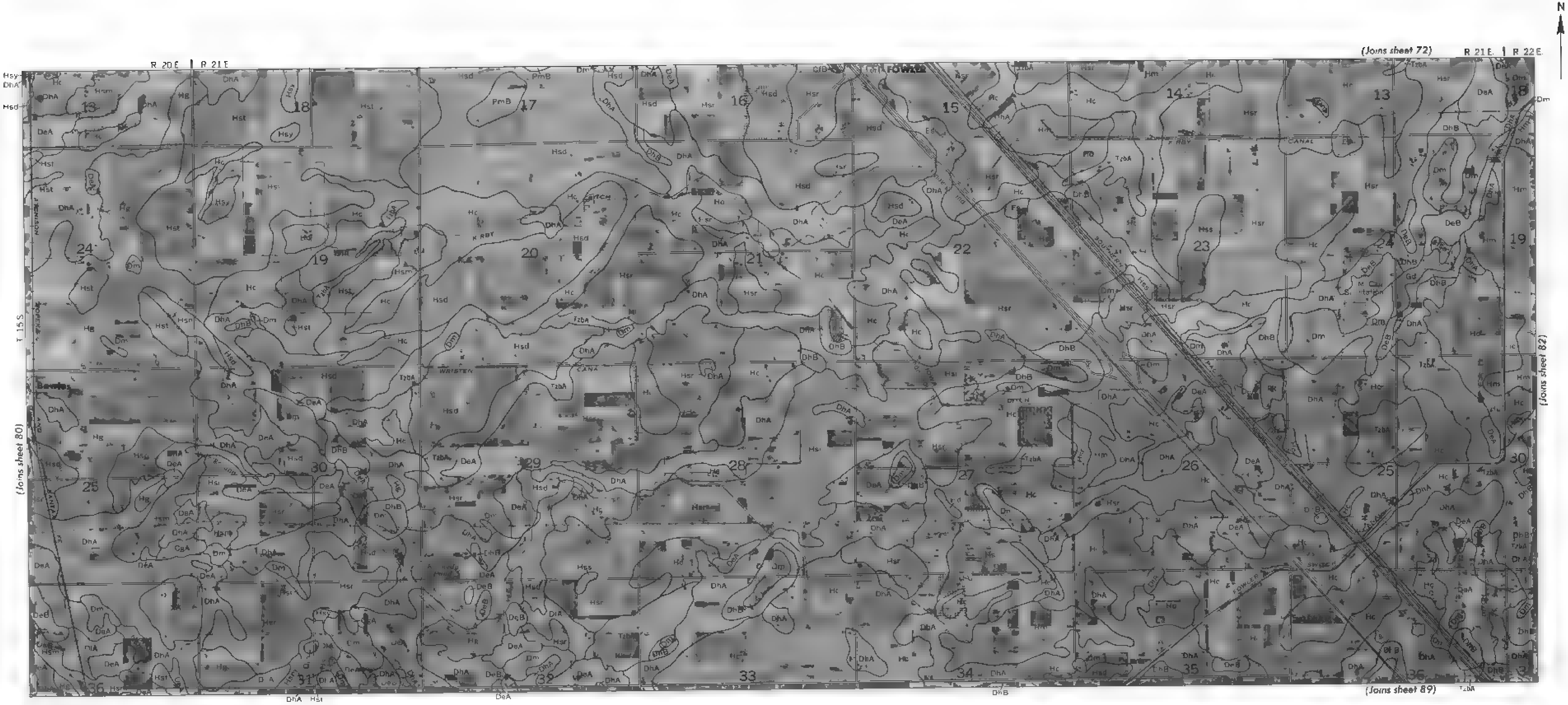


Scale 1:24000

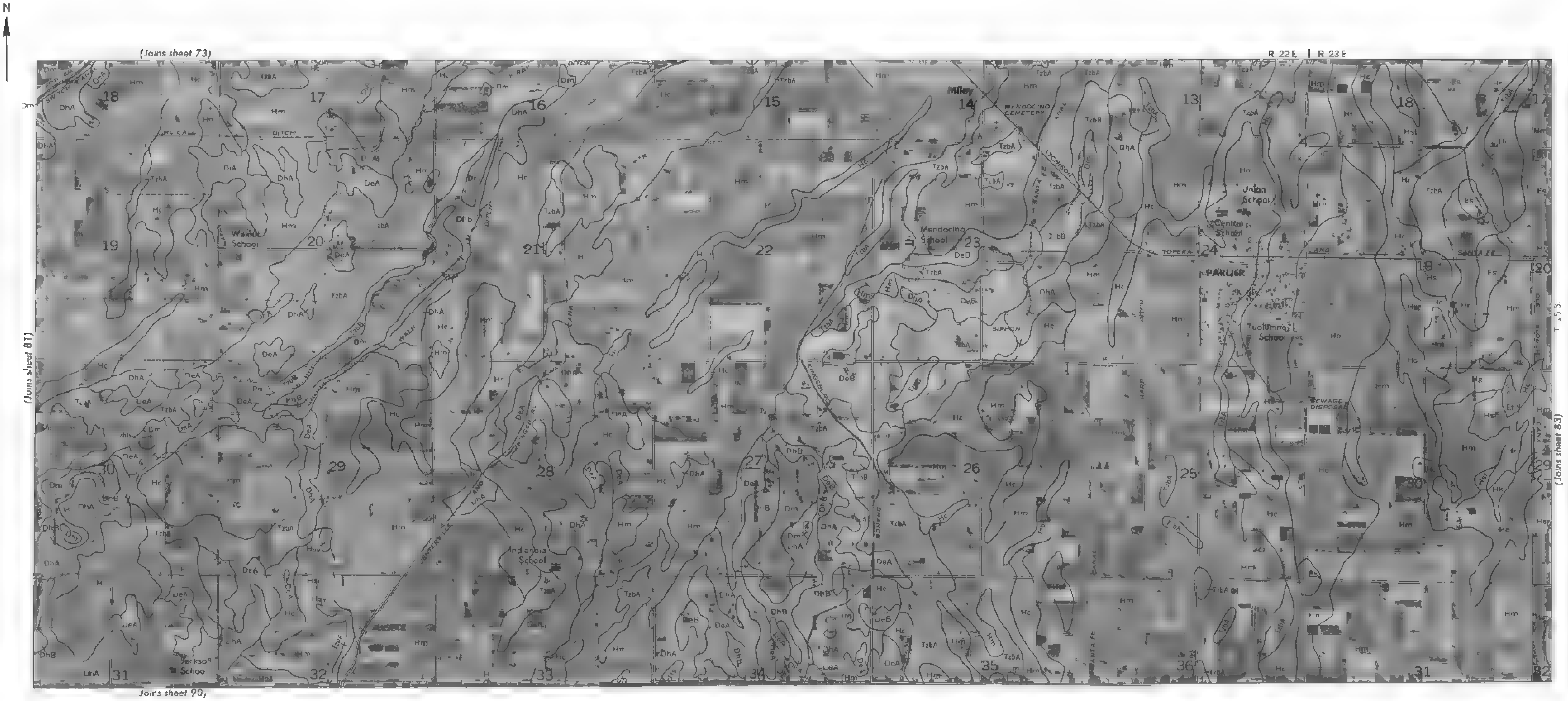
EASTERN FRESNO AREA, CALIFORNIA NO. 80

Land division corners are approximately positioned on this map

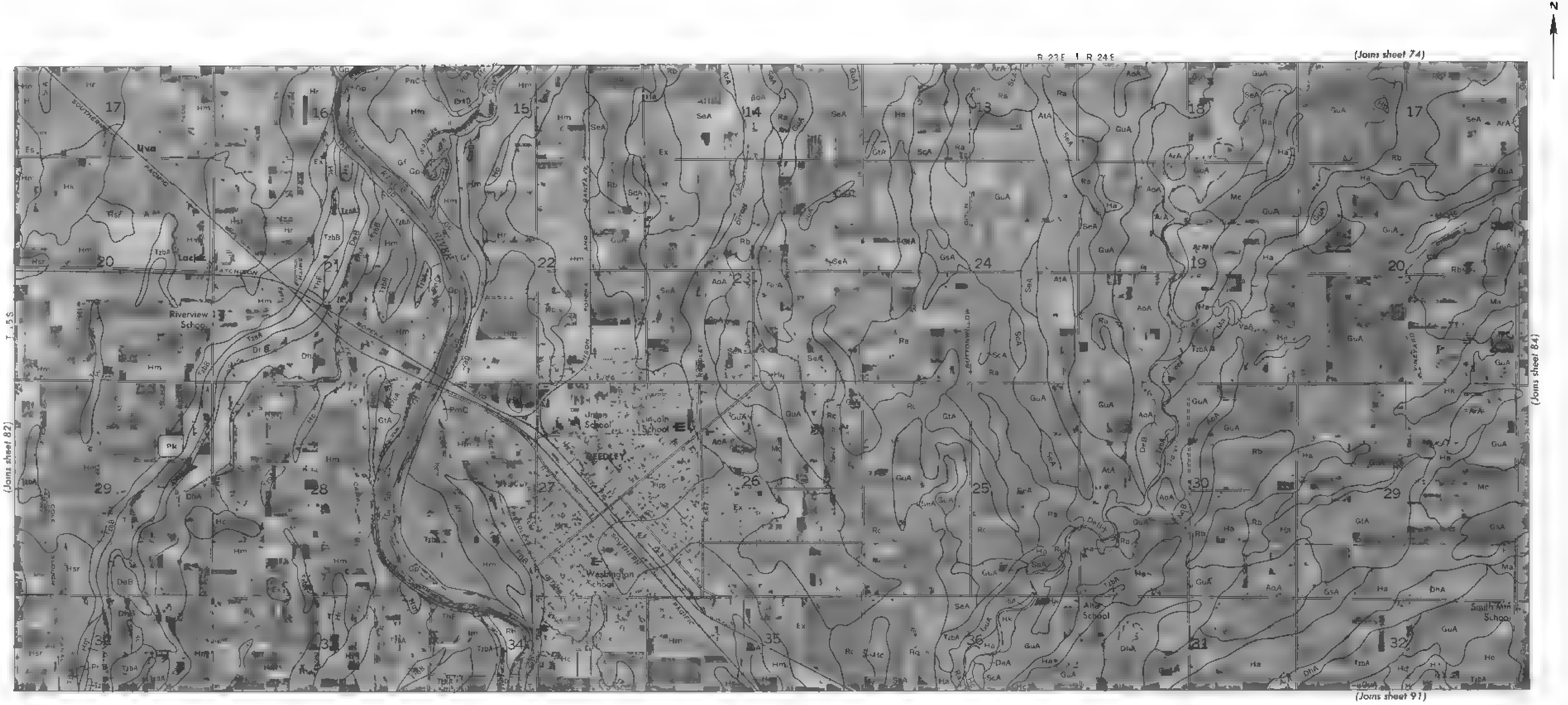
This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.



Scale 1:24000



Scale 1 : 24 000



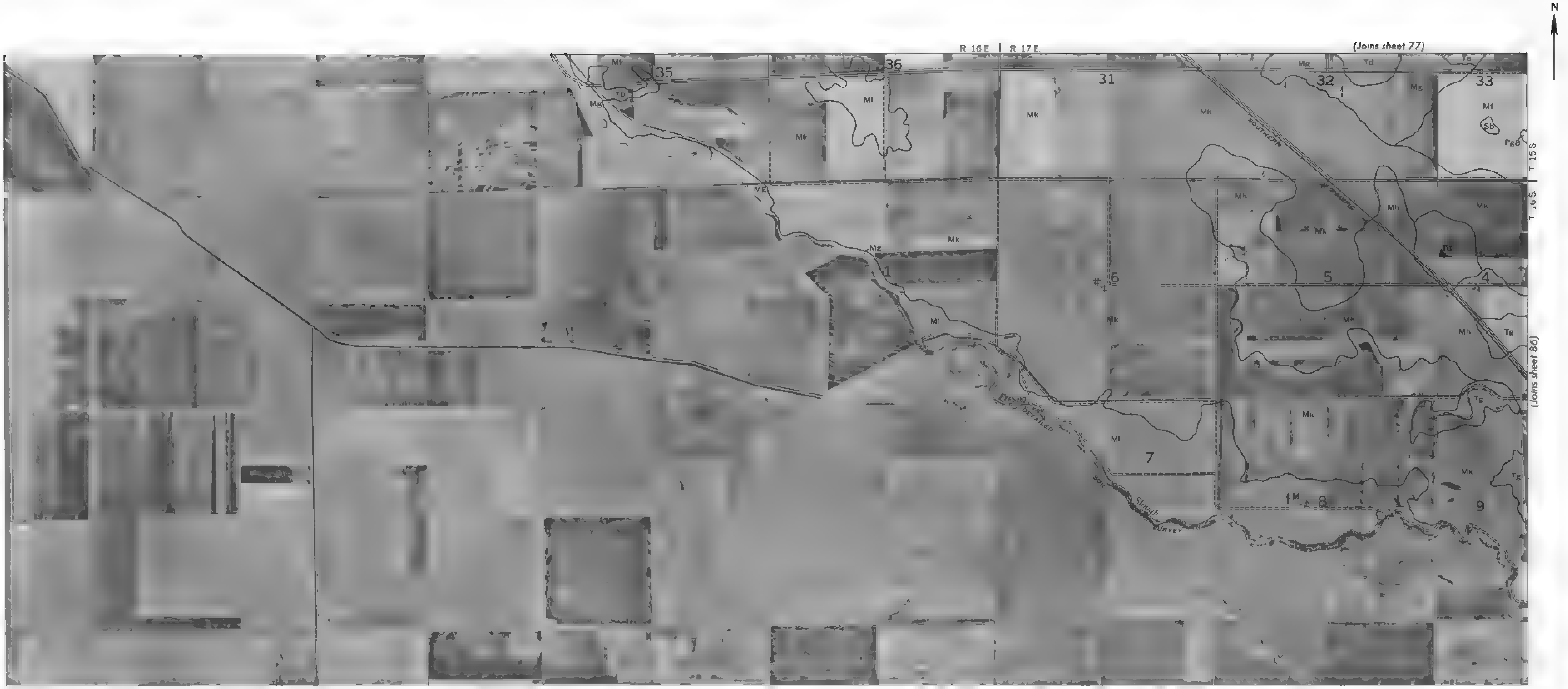
Scale 1:24 000

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 84

EASTERN FRESNO AREA, CALIFORNIA NO. 84

Land division corners are approximately positioned on this map

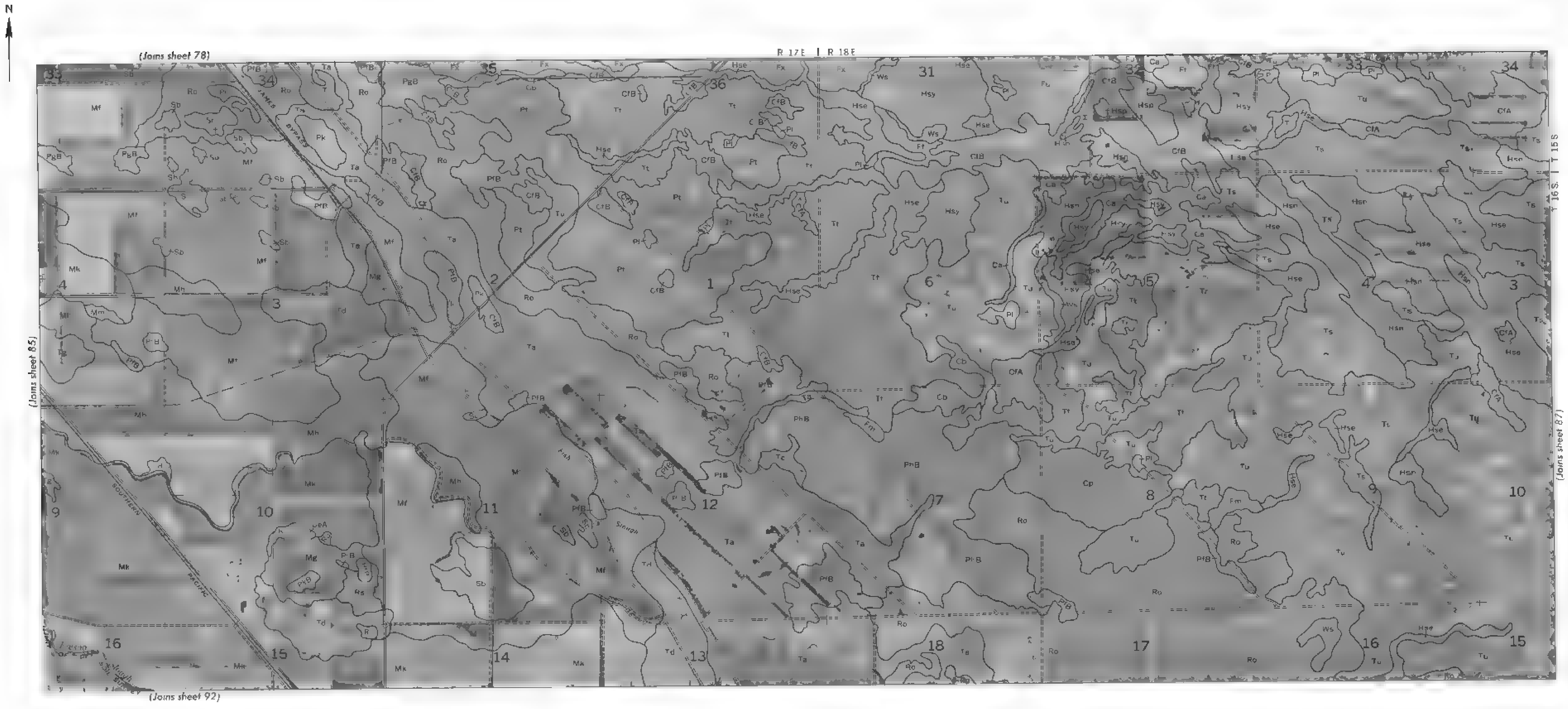
This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station



This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA 85

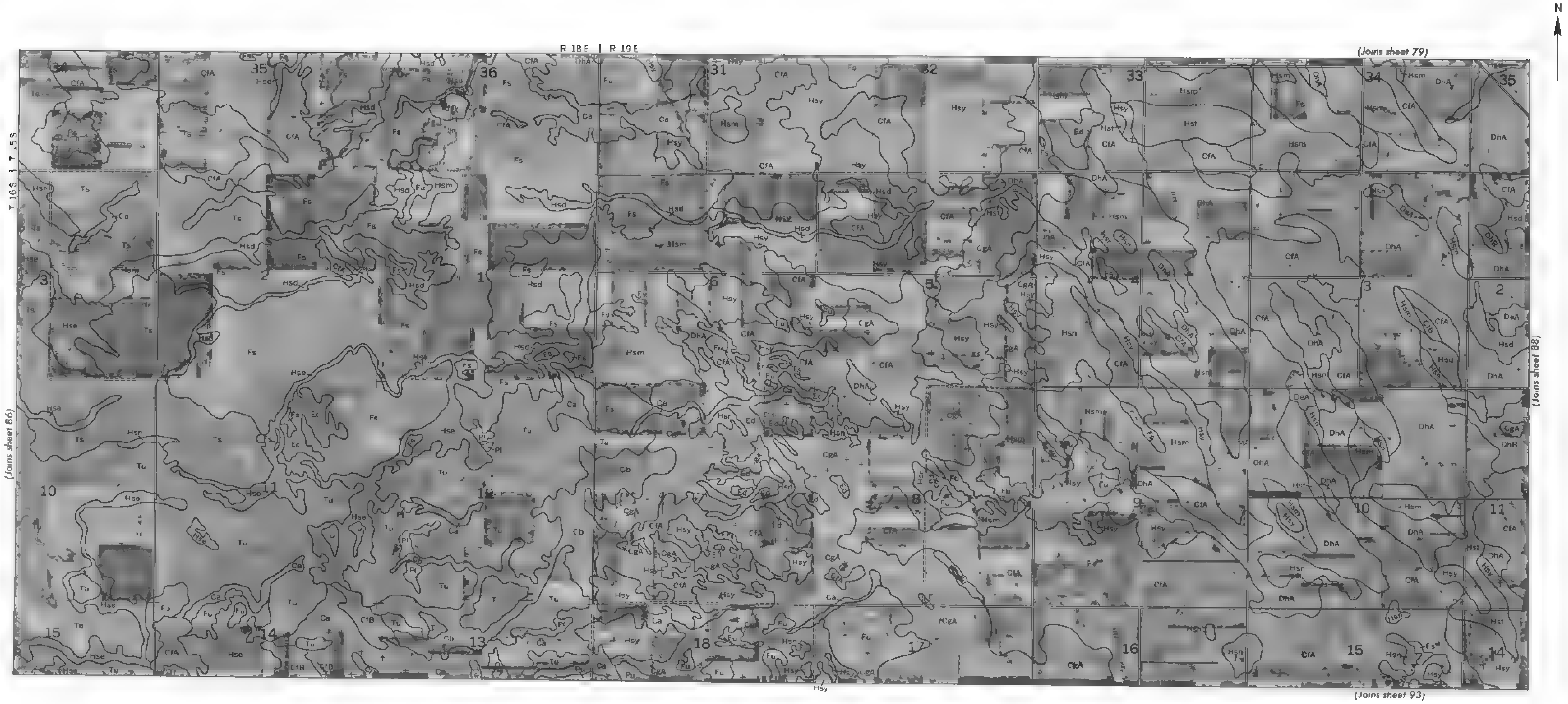
Scale 1:24000



Scale 1:24 000

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA NO. 9

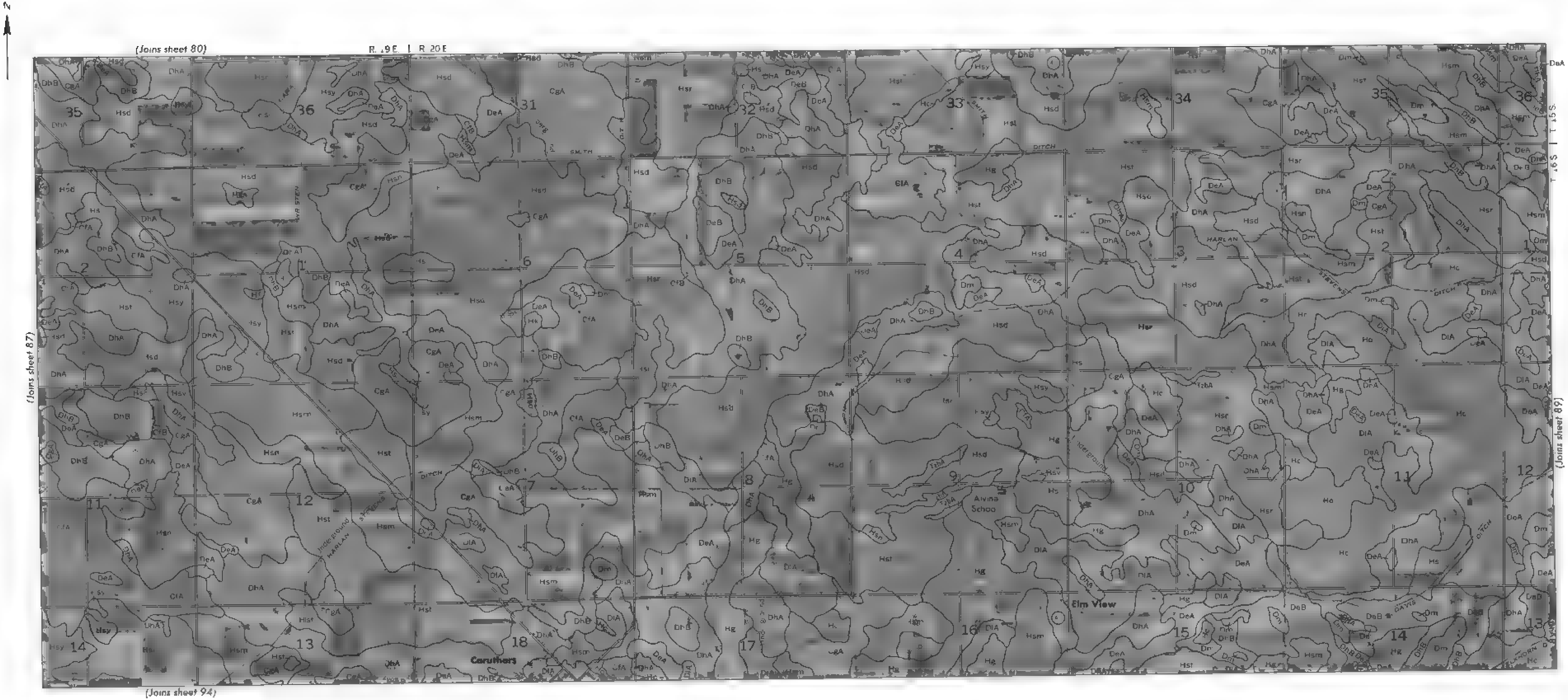


Scale 1:24000

2 Miles

5000 Feet

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 88

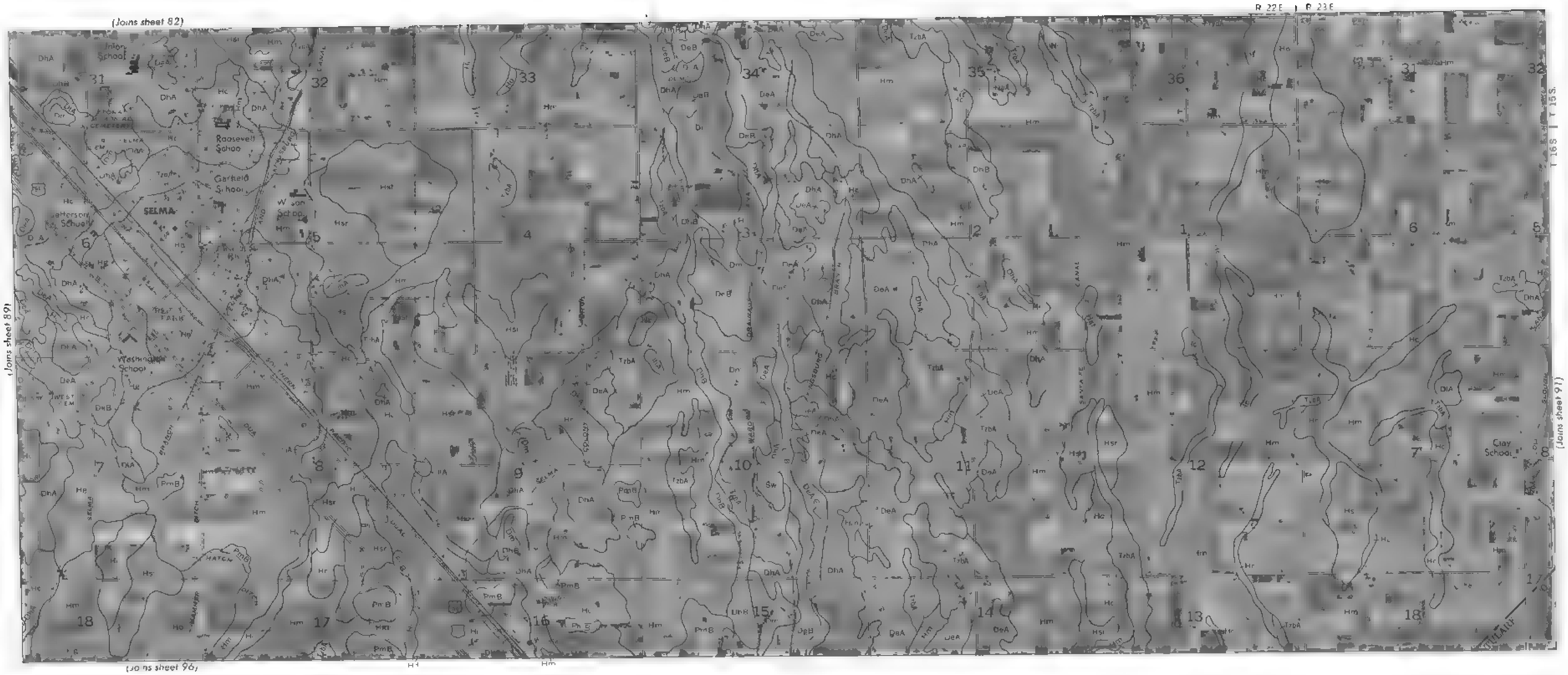


Scale 1:24000

Land division corners are approximately positioned on this map

Scale 1:24000

N



Scale 1:24000

EASTERN FRESNO AREA, CALIFORNIA NO. 90

Scale 1 24000

1 ¾ ½ ¼ 0 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

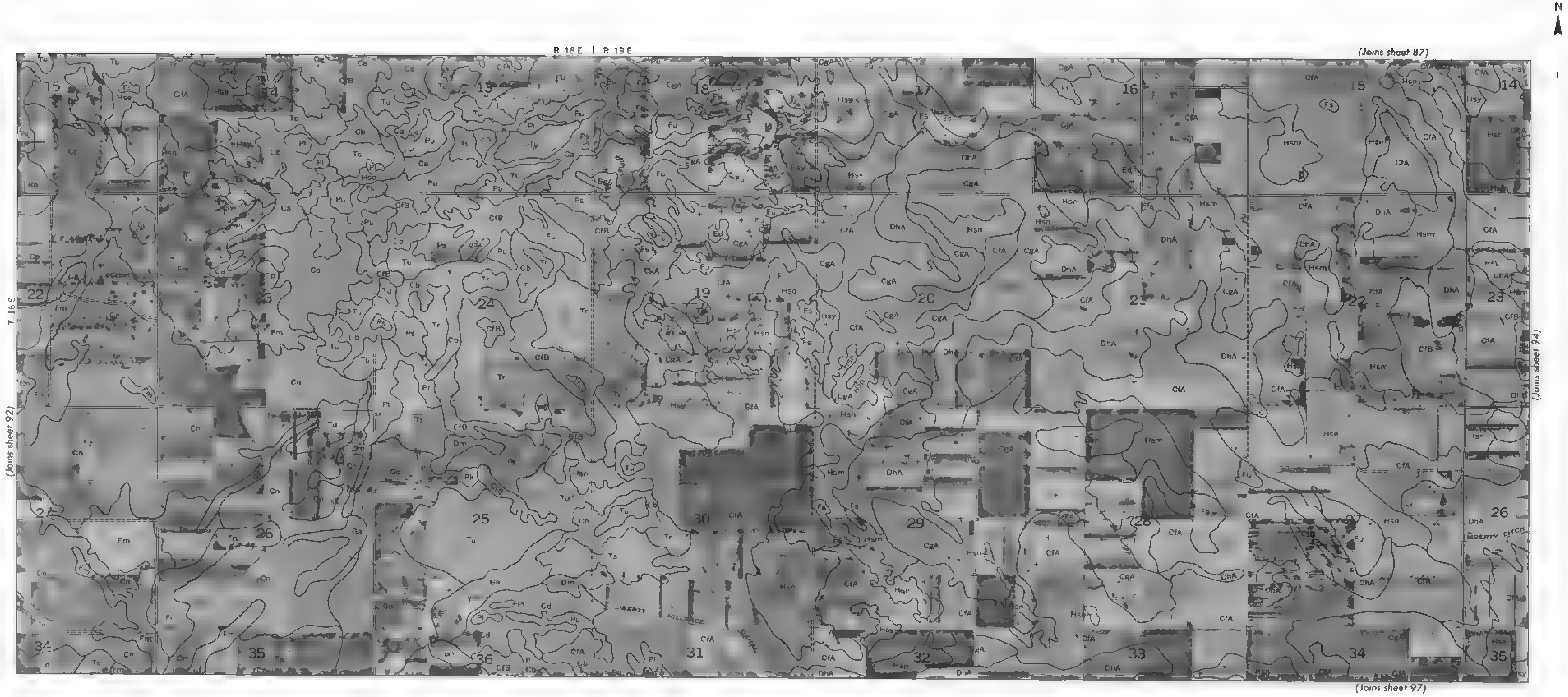
Land division corners are approximately positioned on this map

EASTERN FRESNO AREA, CALIFORNIA NO. 9


N
R 17 E | R 18 E
(Joins sheet 86)
INSET
R 18 E
(Joins lower right)
(Joins sheet 97)
(Joins sheet 93)
(Joins upper left)
T 16 S
T 17 S
Fresno Slough
Southern Pacific
Mk
Td
Ro
Cm
Cn
Cp
Fm
Sb
15
14
13
18
17
16
24
19
20
21
22
30
29
28
27
32
33
34
4
3
10
Scale 1:24000

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture and the University of California Agricultural Experiment Station
Land division corners are approximately positioned on this map

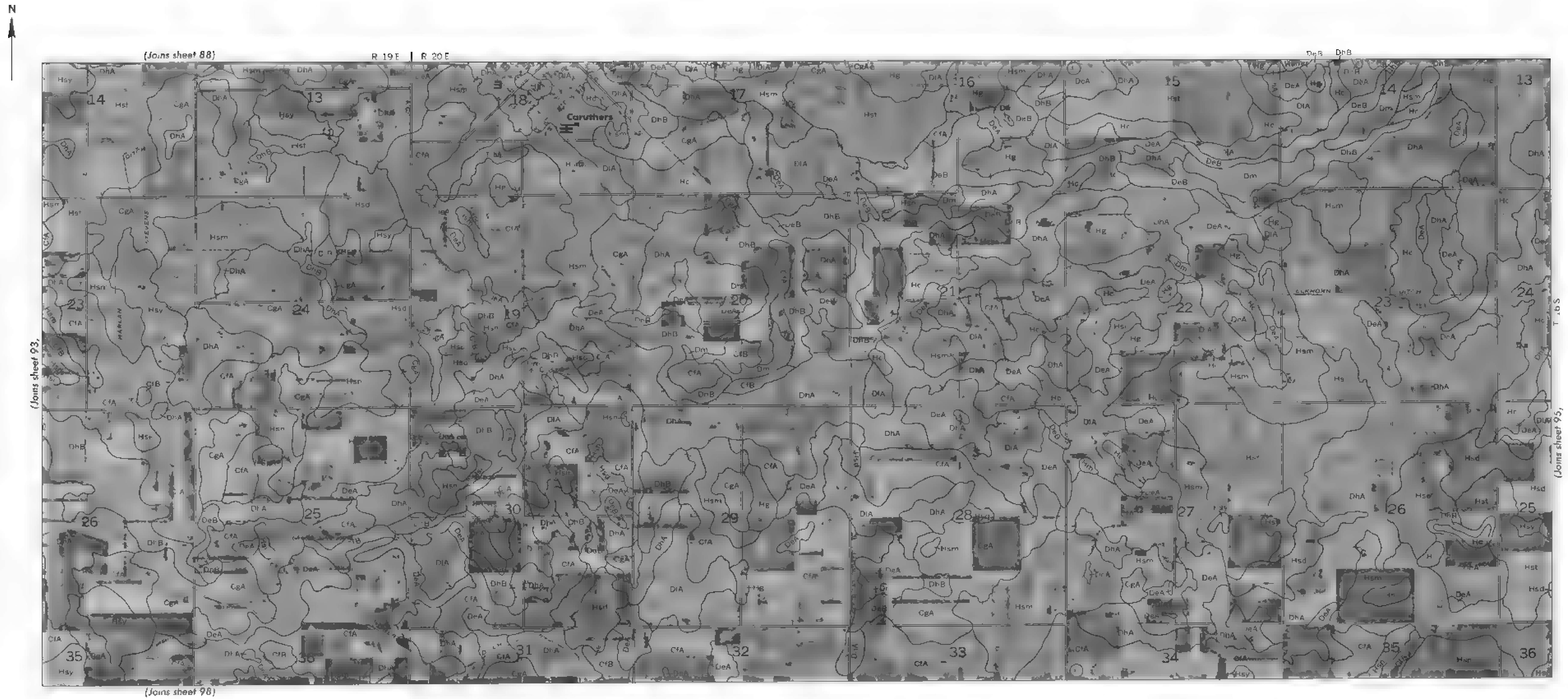
EASTERN FRESNO AREA, CALIFORNIA NO. 93



Scale 1:24000

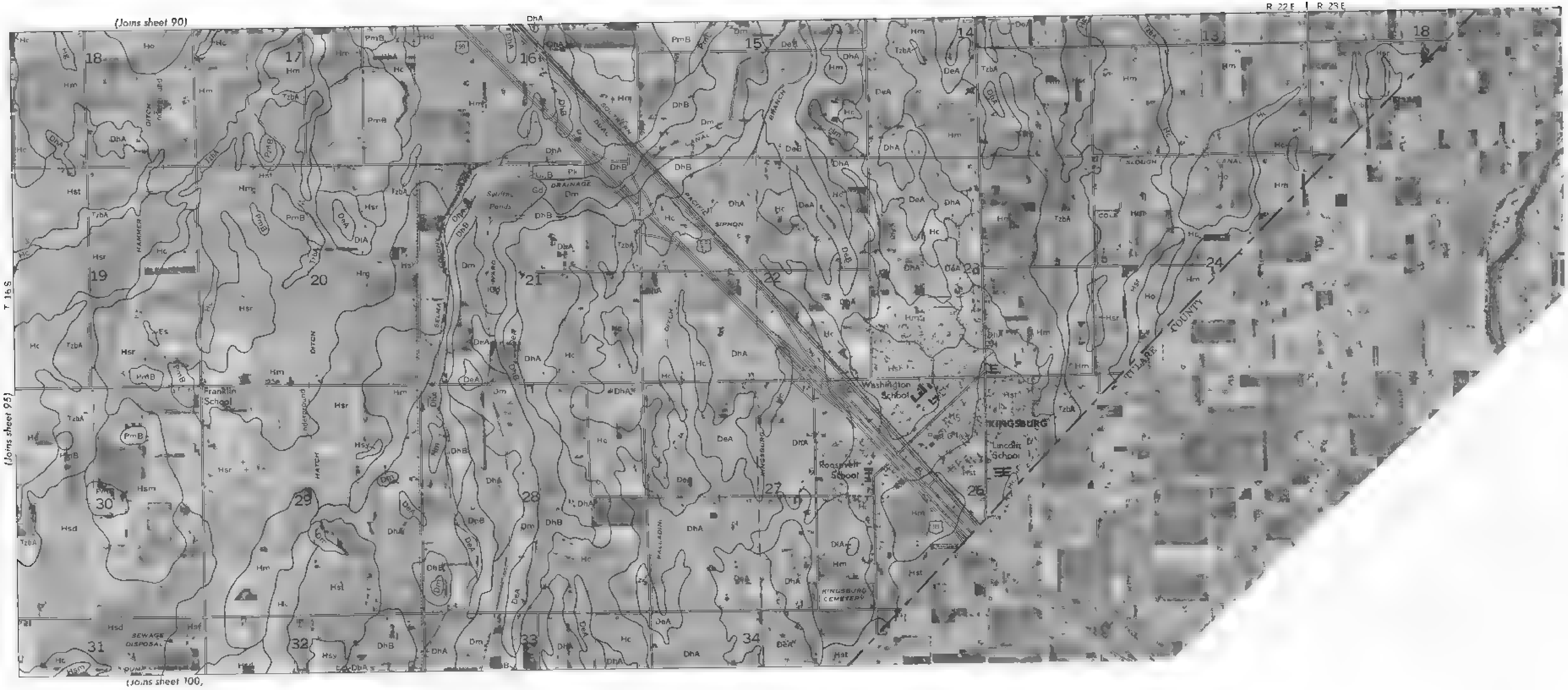
1 Miles

5000 Feet



Scale 1:24 000


N
(Joins sheet 89)
R 20 E
R 21 E
R 22 E
(Joins sheet 94)
(Joins sheet 96)
(Joins sheet 99)
Conejo School
Conejo
Wildflower
Scale 1:24 000



Scale 1:24000

0 — 2 Miles

5000 — 4000 — 3000 — 2000 — 1000 — 0 — 5000 — 10,000 Feet

EASTERN FRESNO AREA, CALIFORNIA NO. 96

Land division corners are approximately positioned on this map

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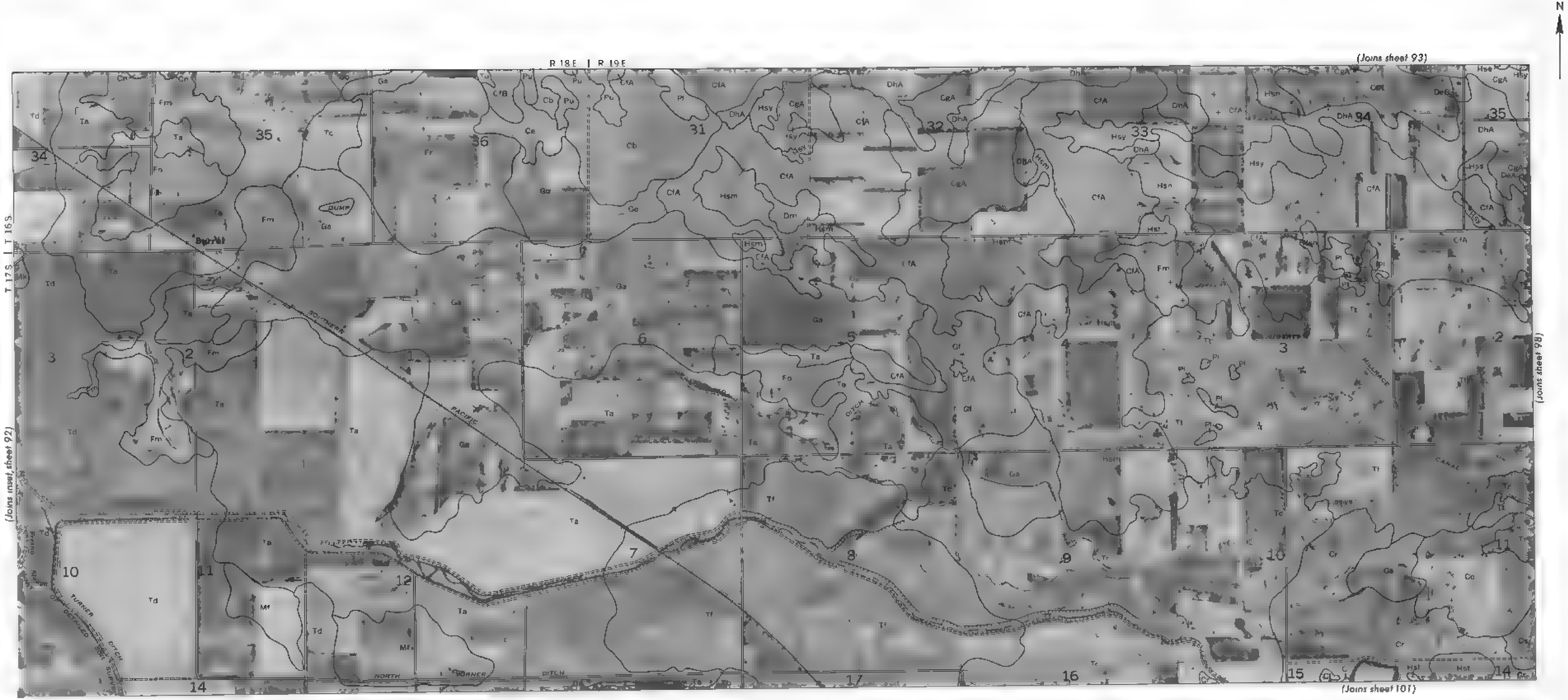
Land division corners are approximately positioned on this map.

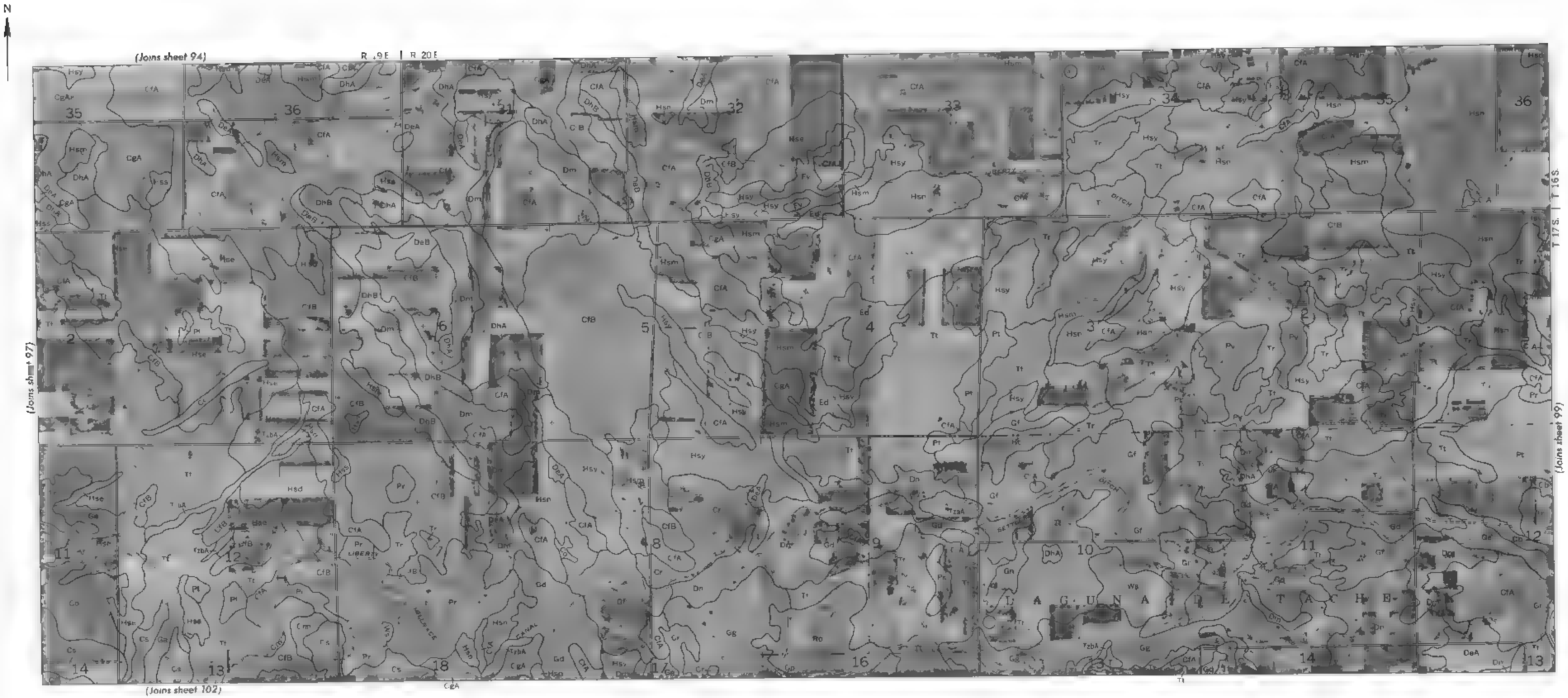
EASTERN FRESNO AREA, CALIFORNIA NO. 97



Scale 1:24 000

5000 4000 3000 2000 1000 0 Feet

0 2 Miles

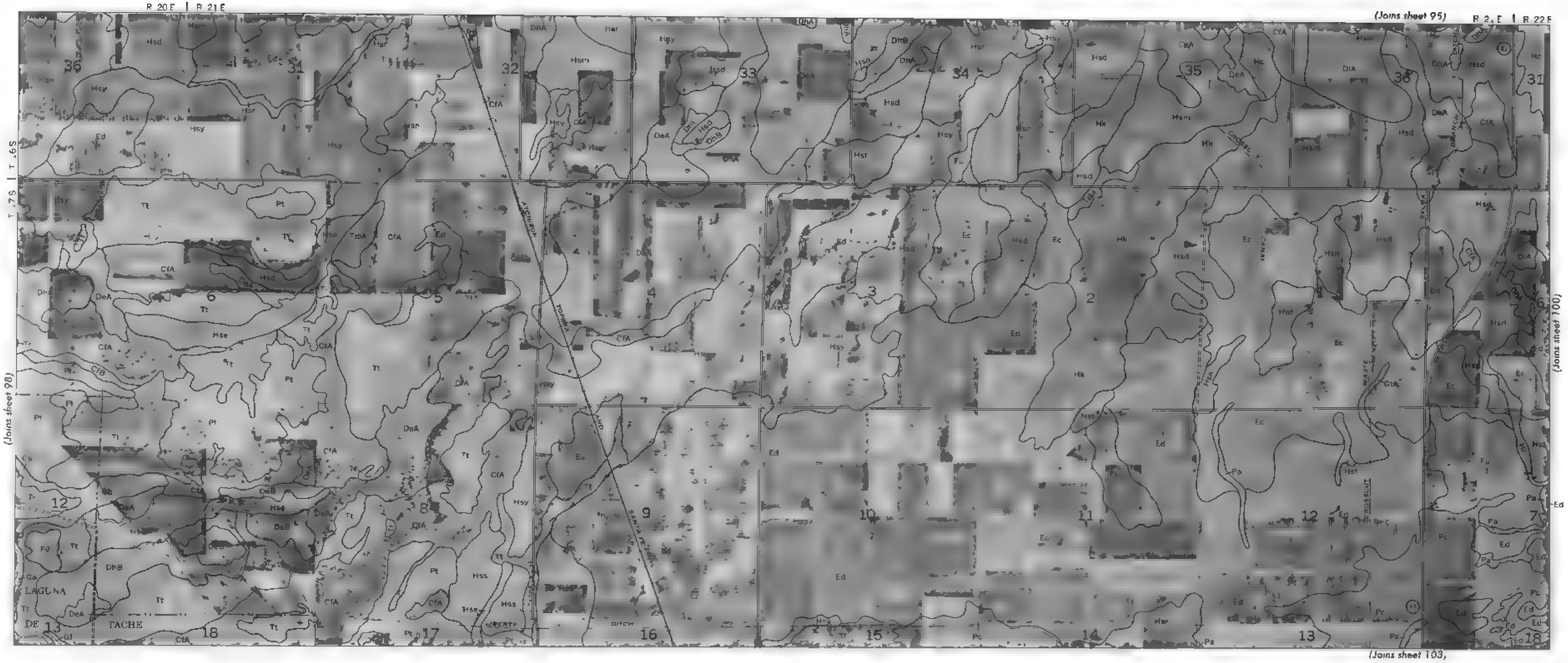


Scale 1:24 000

EASTERN FRESNO AREA, CALIFORNIA NO. 98

Land division corners are approximately positioned on this map

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station



Scale 1:24 000

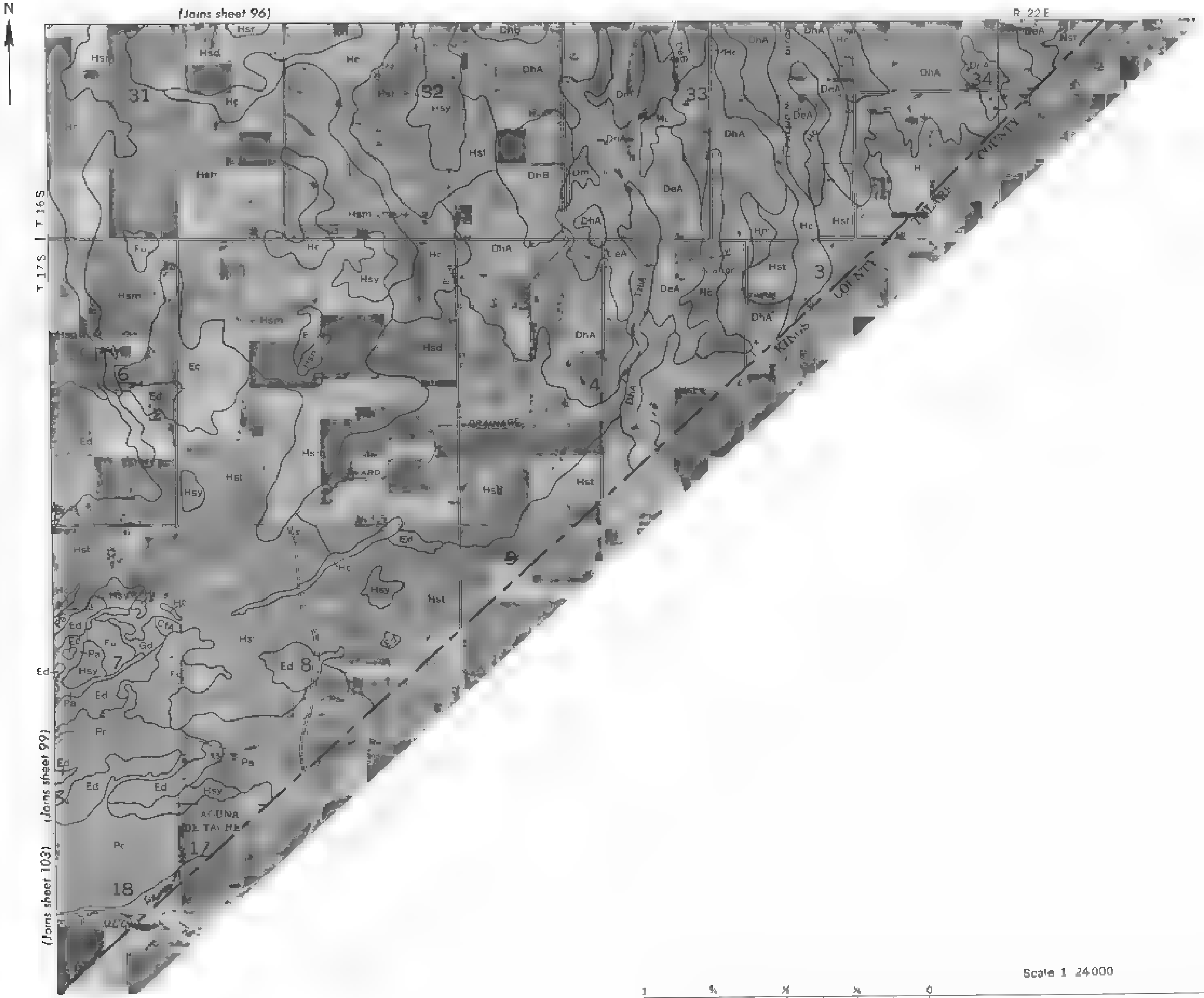
5000 4000 3000 2000 1000 0 5000 10000 Feet

Miles

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA NO. 99



Scale 1:24000

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

EASTERN FRESNO AREA, CALIFORNIA NO. 100

Land division corners are approximately positioned on this map

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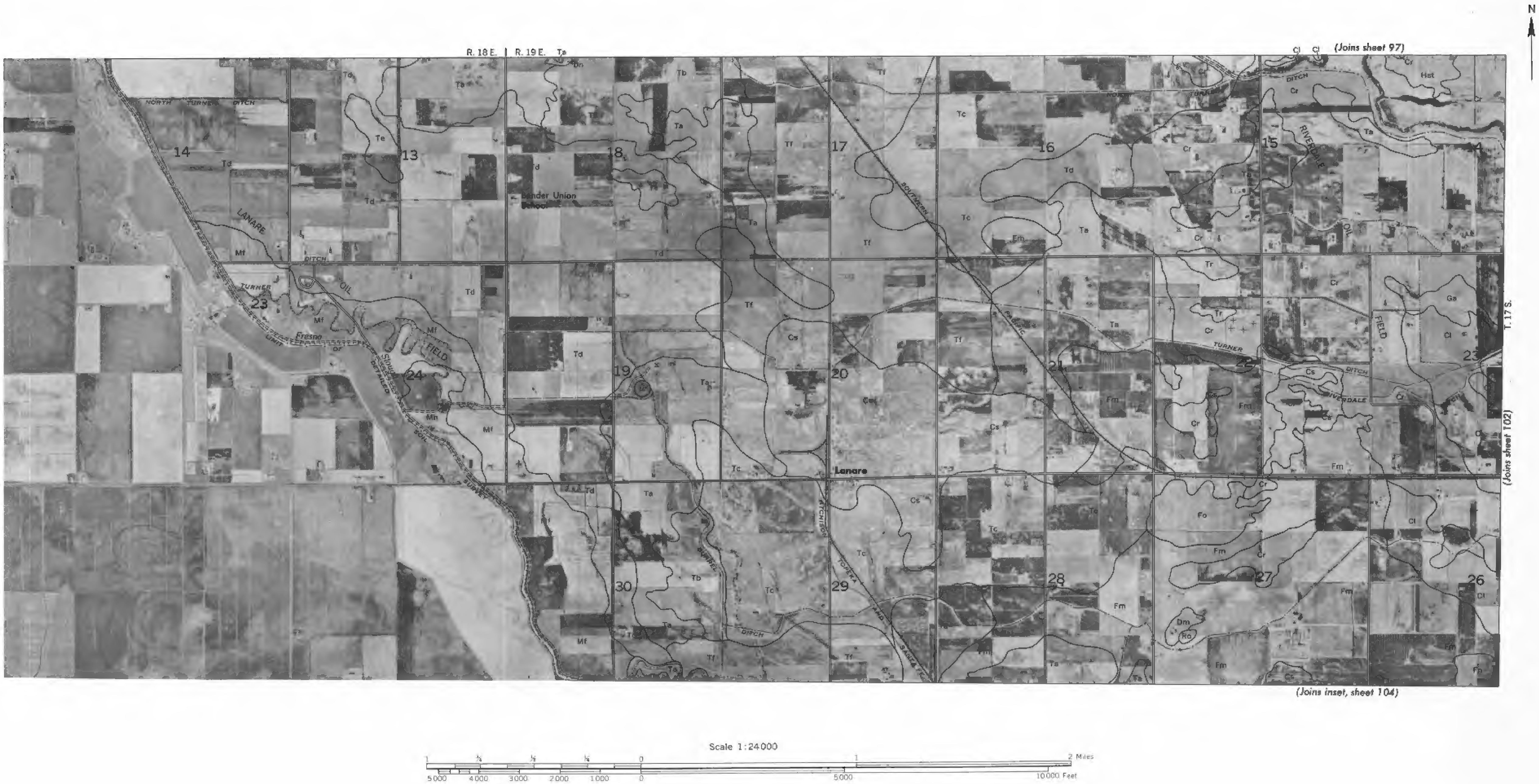


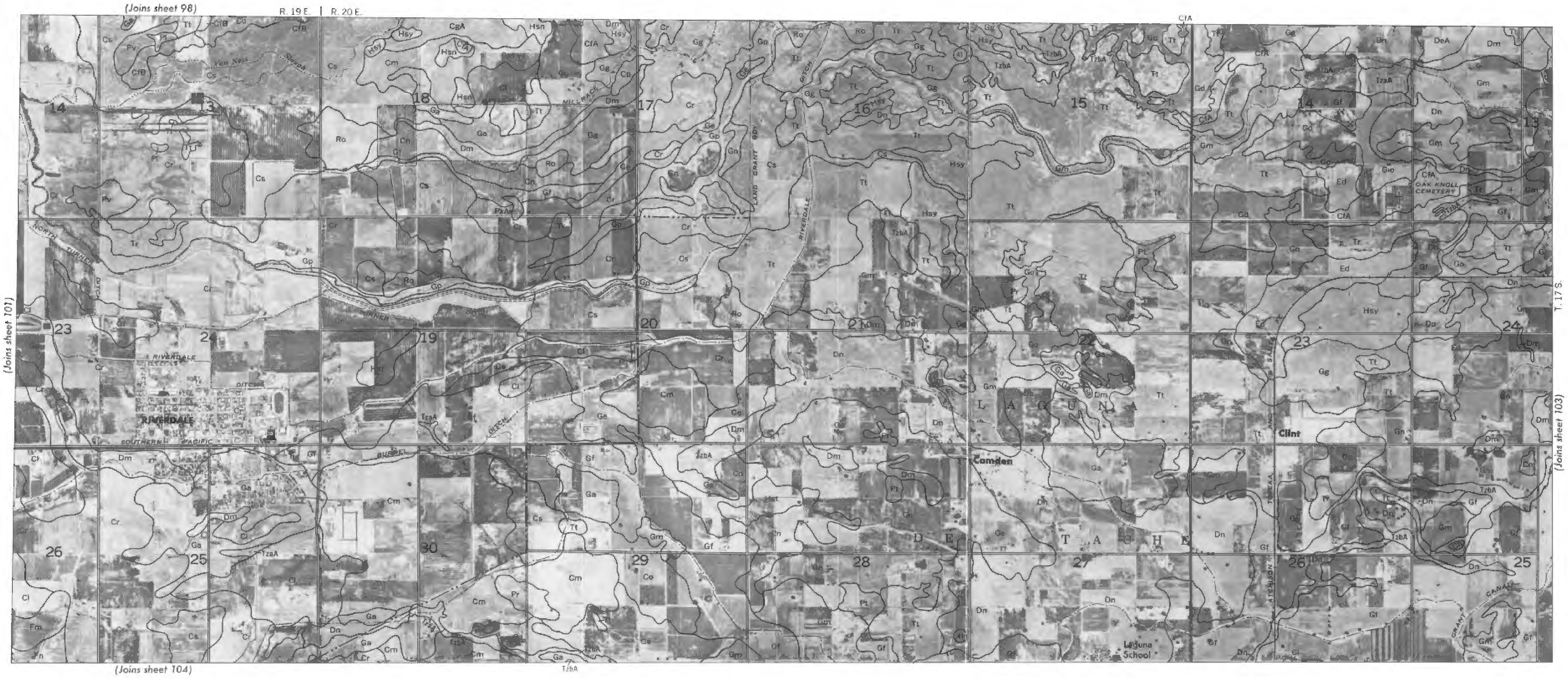
This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

EASTERN FRESNO AREA, CALIFORNIA NO. 101

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 102

N



Scale 1:24 000

1 Mile, ½, 0, 1, 2 Miles
5000, 4000, 3000, 2000, 1000, 0, 5000, 10 000 Feet

EASTERN FRESNO AREA, CALIFORNIA NO. 102

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station.

This map is one of a set compiled in 1968 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the University of California Agricultural Experiment Station
Land division corners are approximately positioned on this map.
EASTERN FRESNO AREA, CALIFORNIA NO. 103

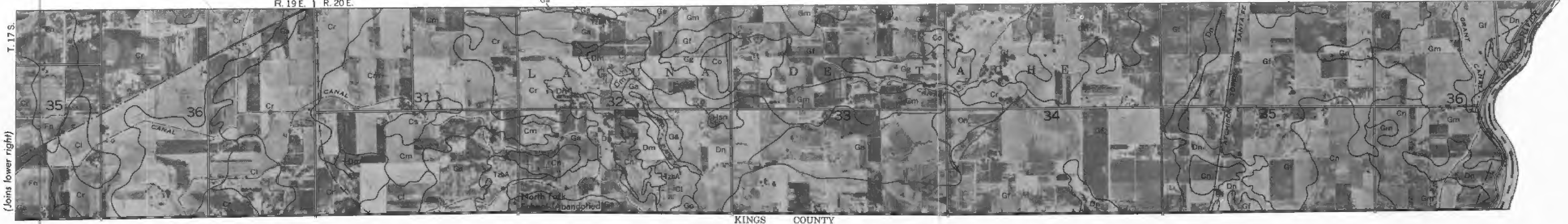
Scale 1:24000

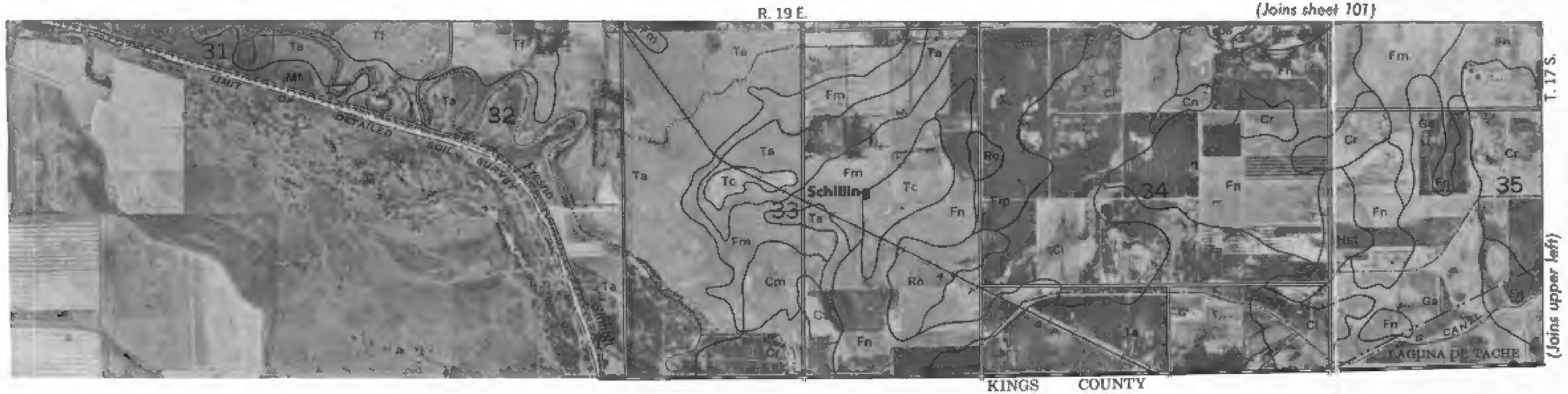
1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

EASTERN FRESNO AREA, CALIFORNIA — SHEET NUMBER 104

N





Scale 1:24 000

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10 000 Feet

EASTERN FRESNO AREZ, CALIFORNIA NO. 104

Land division corners are approximately positioned on this map.

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